INTELLIGENT TRANSPORTATION SYSTEM STRATEGIC PLAN for LAS VEGAS VALLEY

FINAL REPORT

prepared for:

Nevada Department of Transportation
RTC of Clark County
Federal Highways Administration

prepared by:

DKS Associates

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LAS VEGAS VALLEY ITS STRATEGIC PLAN

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CHAPTER 1
INTRODUCTION

1. INTRODUCTION

The problems of urban traffic congestion and air quality are of national concern. The Intermodal Surface Transportation Efficiency Act (ISTEA) of 199 1 established national goals for the development and implementation of advanced technologies to address these problems through coordinated programs. Part B or Title VI of this legislation established Intelligent Vehicle Highway Systems (IVHS) initiatives that included a focused program to address the highest priority corridors in the country. The term IVHS has since been renamed to Intelligent Transportation Systems (ITS) to reflect the multi-modal nature of the program.

This report presents an integrated, multi-modal, phased strategic plan to address the surface transportation needs and problems of the Las Vegas Valley through the use of Intelligent Transportation Systems.

1.1 The Las Vegas Valley ITS Strategic Plan Team

The Nevada Department of Transportation (NDOT) and the Regional Transportation Commission of Clark County (RTC) led the Las Vegas Valley ITS Strategic Plan Team. The team included the following groups:

1. Management Committee
2. Steering Committee, which is the RTC Operations Subcommittee.
3. Consultant Team
4. Four working groups composing of public and private stakeholders.
5. Advisory Panel

The Management Committee provided management oversight of the consultant's work and monitored the study's progress. It comprises:

- Keith Maki, Research Division Chief of the Nevada Department of Transportation
- Dennis Mewshaw, Senior Planner for the Regional Transportation Commission of Clark County (RTC).

The Steering Committee set the strategic direction for the ITS planning effort, and served as the reviewing body for all deliverables. The Steering Committee's members include:

- John Bartels, City of Henderson
- Ray Burke, City of North Las Vegas
- Gary Johnson, RTC of Clark County
- Captain Carl Frug'e, Las Vegas Metropolitan Police Department
- Glenn Grayson, City of Las Vegas
- Gerry de Camp, LVACTS
- P.D. Kiser, Nevada Department of Transportation
- Dick Renshaw, City of Boulder City
- Rich Romer, Clark County Traffic Management
- Kent Sears, Nevada DOT District I HQ

The Steering Committee met monthly as part of the RTC Operations Subcommittee agenda to discuss project status and progress, and for the consultant team to present findings. In addition, the Steering Committee members took part in several workshops to provide input to the project. These workshops included:

- User Service Prioritization Workshop
- Project Concepts Workshop, jointly with the working groups.
- Project Implementation Workshop, jointly with the working groups.

The consulting team commissioned by Nevada DOT and Clark County RTC included the following team members:

- DKS Associates (prime consultant)
- Apogee Research, Inc.
- Collins Communications
- Rockwell International, Inc.
- FPL Associates

An advisory panel was formed to review the project deliverables. The panel comprised:

- Jeff Georgevitch of Metropolitan Transportation Commission
- Dr. Paul Jovanis of UC Davis
- Jim Wright of Minnesota Department of Transportation

Four working groups were established for this project. These working groups involve stakeholders from the public and private sector. Members of these four working groups included:

Traffic Control Working Group

- D. Keith Maki, NDOT
- Dennis Mewshaw, RTC of Clark County
- Greg Novak, FHWA
- P.D. Kiser, NDOT
- Glenn Grayson, City of Las Vegas
- Ray Burke, City of North Las Vegas
- John Bartels, City of Henderson
- Rich Romer, Clark County Traffic Management
- Gerry de Camp, LVACTS
- Gary Johnson, RTC of Clark County
- Steve Oxoby, NDOT - Design
- Kent Sears, NDOT - District I HQ
- Gene Weight - NDOT - District I HQ
- Dr. Shashi Sathisan - UNLV-TRC
- Ms. Pat Manry, NDOT Planning Division

Traveler Information Working Group

- D. Keith Maki, NDOT
- Dennis Mewshaw, RTC of Clark County
- Greg Novak, FHWA
- Rich Romer, Clark County Traffic Management
- P.D. Kiser, NDOT
- Tom Smith, Convention Authority
- Jacob Snow, Airport Department
- Alma Bromley, Resort Association
- Glenn Grayson, City of Las Vegas
- Gerry de Camp, LVACTS
- Tom Hawley, KVBC-TV Ch 3
- Bobby Shelton, NDOT - District I HQ
- Dr. Shashi Sathisan, UNLV-TRC
- Ms. Pat Manry NDOT Planning Division

Incident Management Working Group

- D. Keith Maki, NDOT
- Dennis Mewshaw, RTC of Clark County
- Greg Novak, FHWA
- Jim Gallegos, NDOT Safety
- Captain Carl Frug'e, Las Vegas Metropolitan Police Department
- Captain Ronald Levine, NHP
- Deputy Chief Ken Riddle, LV Fire Department
- Chief William Bunker, Clark County Fire Department
- Chief Dale Nisson, NLV Fire Department
- Mr. Paul Corbin, Office of Traffic Safety
- Tanya Martin, California AAA
- Shelly Cochran Mercy Ambulance
- Deputy Chief Tim Ryan, North Las Vegas Police Department
- Officer Randy Mazner, Henderson Police
- Captain Terry Mayo, Regional 911 Committee
- Bob Andrews, Clark County Emergency Management
- Rich Romer, Clark County Traffic Management
- Dr. Shashi Sathisan, UNLV-TRC
- Ms. Pat Manry, NDOT Planning Division

Public Transit Working Group

- D. Keith Maki, NDOT
- Dennis Mewshaw, RTC of Clark County
- Greg Novak, FHWA
- Linda Tunstall, RTC of Clark County/CAT Management Team
- Dean Greenwood, RTC of Clark County
- Rich Boxer, Taxicab Authority
- Elgin Simpson, Ray & Ross Transport
- Richard Gull, Bell Shuttle
- Jim Mallery, NDOT - Modal Management
- Steve Thorns, ATC Vancom
- Dr. Shashi Sathisan, UNLV-TRC
- Ms. Pat Manry, NDOT Planning Division

The four working groups met four times in workshops:

- User Needs Assessment Workshop
- Project Concepts Workshop
- Project Evaluation Workshop
- Project Implementation Activities Workshop

1.2 The ITS Strategic Planning Process

Preparation of the Las Vegas Valley ITS Strategic Plan has followed the ten step ITS Planning Process developed by the Federal Highway Administration. This process is illustrated in Figure 1-1.

The federal ITS planning and deployment process emphasizes the significance of a strategic approach based on user-needs and a strong institutional coalition. The deployment of ITS should be structured and strategic in order to avoid inefficiencies and to insure that ITS potential be fully realized. Deployment should be based upon solving local user needs rather than simply looking for opportunities to utilize new technologies. Finally, successful deployment depends upon development of an institutional framework and coalition of transportation agencies and other stakeholders. Such a coalition, and the cooperation it fosters, helps insure that each agency's needs, constraints, opportunities and responsibilities are addressed, and that the resulting system meets the needs and expectations of each agency and the public.

1.2.1 Accompanying Documents

The consultant team followed the federal ITS planning process in this project, leading to the development of three accompanying documents which support this Strategic Plan. These three documents consist of

- User Service Plan, which summarizes steps 1 to 3 of the FHWA ITS planning process.
- Functional Area Plan, which summarizes steps 4 and 5 of the FHWA ITS planning process.
- Technology Assessment Report, which summarizes steps 6 and 7 of the FHWA ITS planning process.

This report, the Strategic Deployment Plan combines the cumulative efforts of the previous steps and represents step ***8*** of the FHWA ITS planning process. Steps 9 and 10 relate to the deployment of projects, and the evaluation their success to update the plan in future.

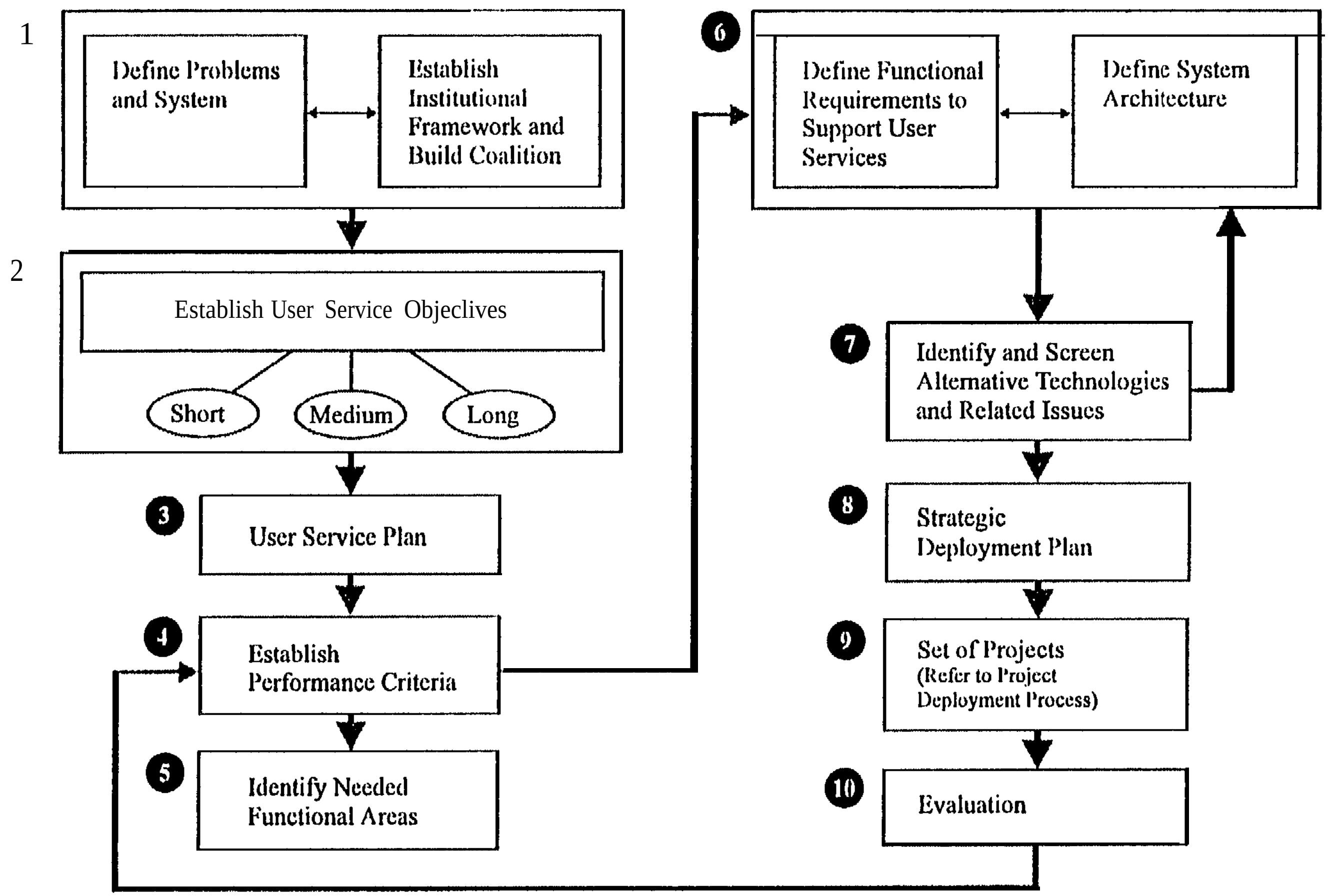
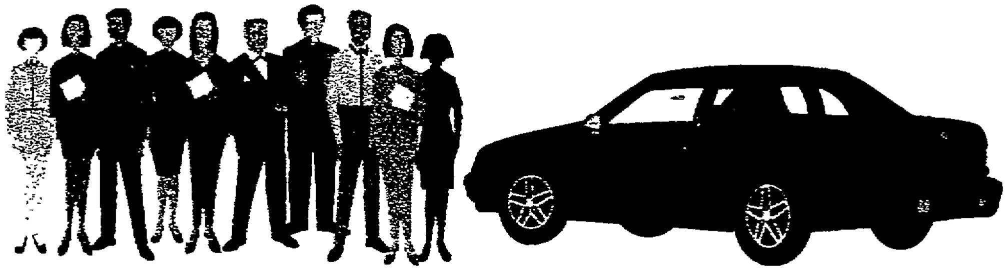


Figure 1-1
ITS Planning Process

1.3 Organization of the Strategic Deployment Plan

This document represents the results of the final step of the ITS strategic planning process. Chapter 2 outlines the key travel and traffic characteristics within the Las Vegas Valley This information formed the backbone of the subsequent benefit/cost analyses of the ITS elements. Chapter 3 provides a detailed description of the project concepts that resulted from the working groups. Chapter 4 discusses the high priority programs that were developed as a product of a workshop involving the Steering Committee and the joint working groups. These high priority programs were subsequently approved by the RTC for implementation within the next 5 years. Chapter 5 summarizes the regional benefits assessment of these high priority programs. Chapter 6 discusses the US Highway 95 pilot corridor, which was identified by the NDOT as the initial corridor for ITS deployment. Chapter 7 provides an overview of the necessary system architecture. Chapter 8 discusses project implementation activities, costs, funding, and potential private sector roles.



CHAPTER 2
TRAVEL AND TRAFFIC CHARACTERISTICS

2. TRAVEL AND TRAFFIC CHARACTERISTICS

2.1 Regional Characteristics

The Las Vegas Valley is bounded by the Sheep Mountain Range to the north, the Lake Mead National Recreation area to the east, the Spring Mountain Range to the west and the McCullough Mountain Range to the south. This area encompasses approximately 850 square miles.

The Las Vegas Valley consists of three incorporated cities (Henderson, North Las Vegas, and Las Vegas), and a large unincorporated urbanized area of Clark County. A map illustrating the study area and jurisdictional boundaries is presented in Figure 2-1.

The Las Vegas Valley and Clark County have experienced unprecedented levels of growth over the last decade. Recent projections based on census estimates have placed the population at approximately 1 million people, which represents an average growth rate of 4.5% per year for each of the last five years. If this trend continues, Clark County could expect to grow by another 250,000 people by the turn of the century. Table 2.1 presents the population statistics for the Las Vegas Valley, listing Year 1990 and 1994 census data and Year 2010 forecast population is listed for Clark County unincorporated areas, and the cities of Las Vegas, North Las Vegas, Boulder City, Mesquite and Henderson.

TABLE 2.1: Clark County Population Summary

CITY/COUNTY	1990	1994	2000	2010
Boulder City	12,760	13,640	17,280	25,173
Henderson	69,390	105,610	133,791	194,904
Las Vegas	268,330	346,350	438,770	639,192
Mesquite	1,960	3,850	4,877	7,105
North Las Vegas	50,030	69,700	88,299	128,632
Unincorporated County	367,810	432,530	547,946	798,239
TOTAL	770,280	971,680	1,230,963	1,793,245

Source: NSBDC, Bureau of Business and Economic Research

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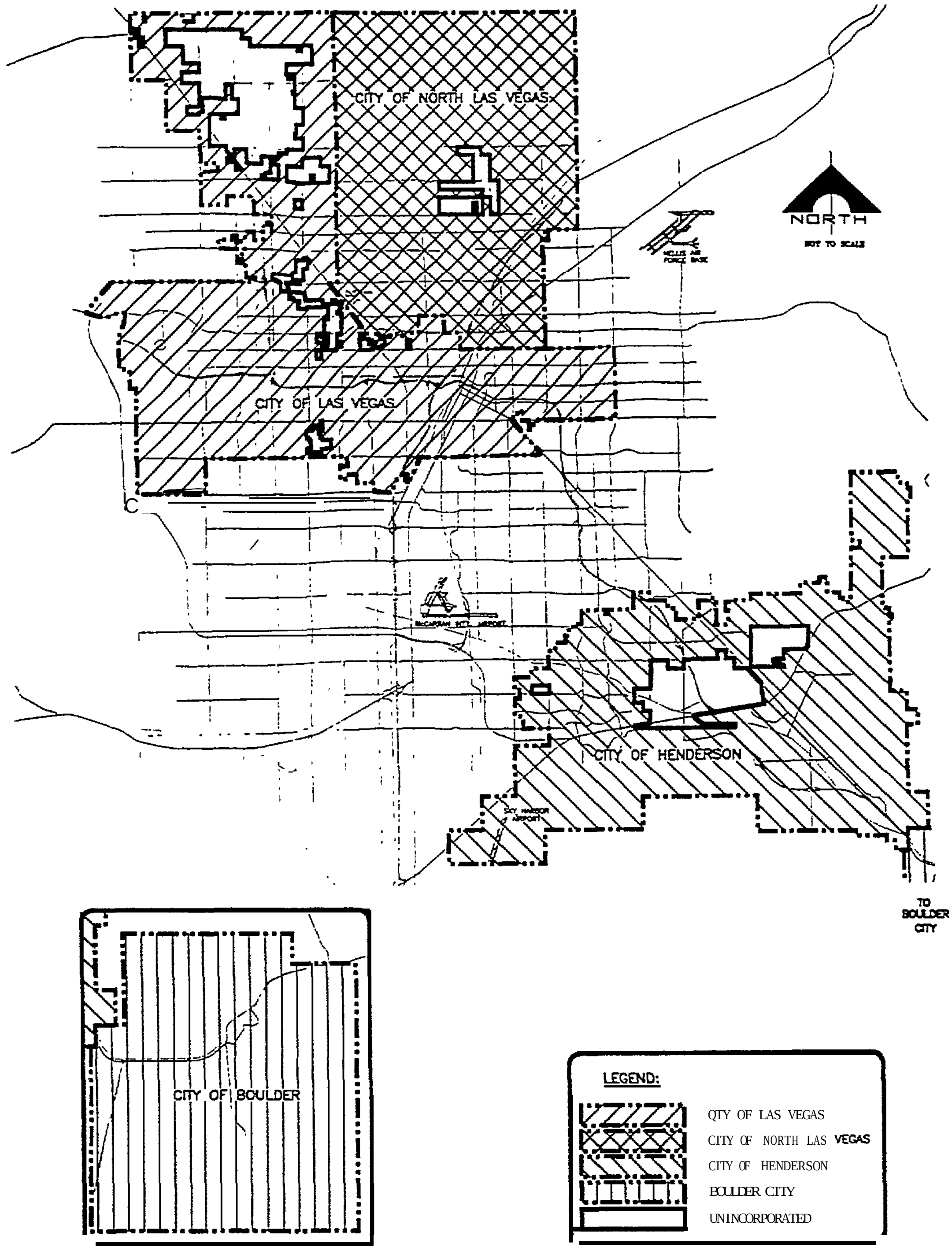

Figure 2-I
Study Area

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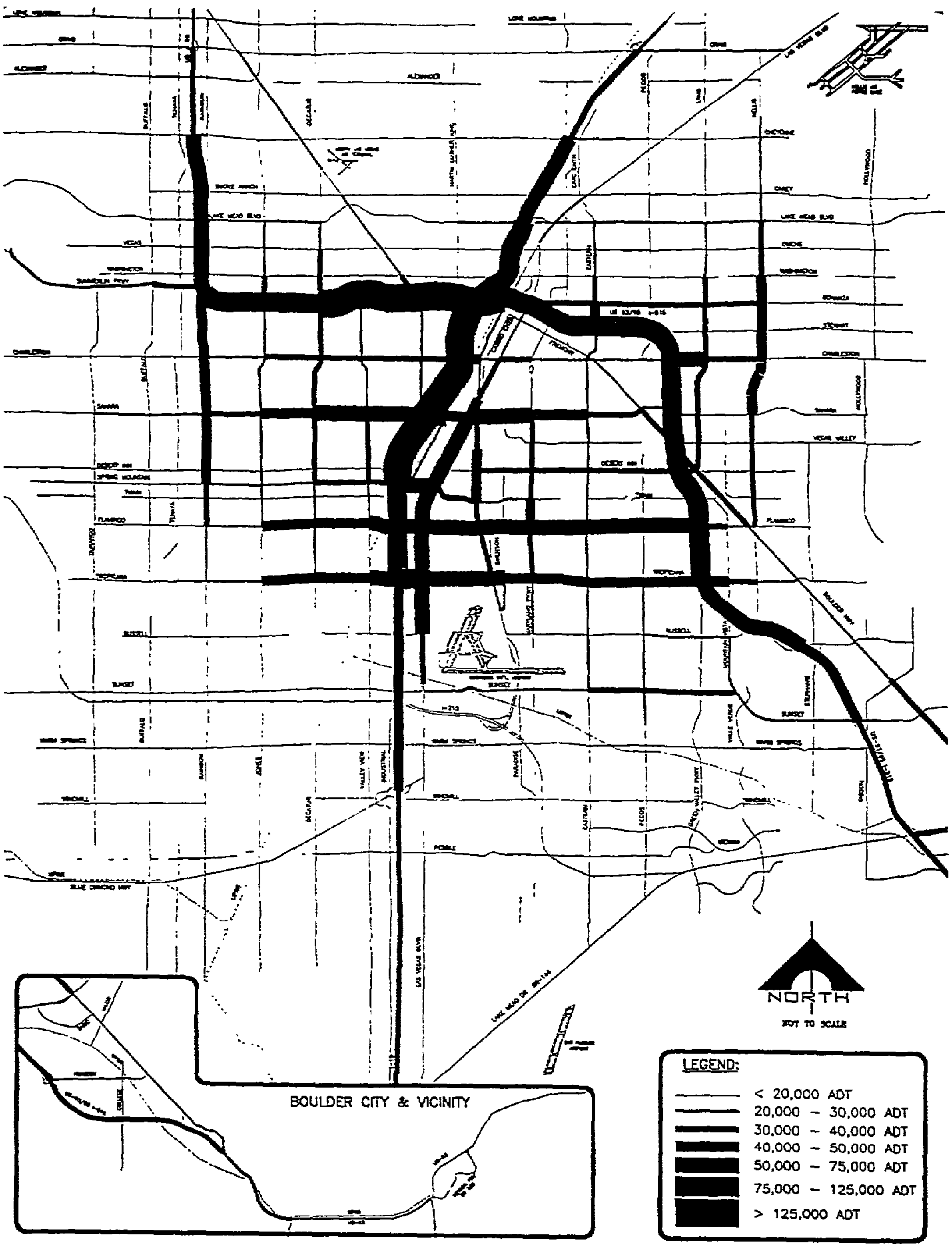

Figure 2-2
1993 Average Daily Traffic Volumes

2.2 Roadway Network

The Las Vegas Valley freeway system currently consists of two major facilities, Interstate 15 and US Route 95 including a portion of I-515. Interstate 15, which runs from southern California to Salt Lake City, Utah, provides north-south line haul movement through the Valley. US Route 95, which runs from the California stateline near Needles to north of Winnemucca, Nevada, provides primarily northwest-southeast line haul movement through the Valley, but does run in an east-west direction for approximately 9 miles through the central portion of the Las Vegas metropolitan area. US Route 93, which is also located through the Valley, runs from Boulder Dam to Jackpot, Nevada overlapping both US Route 95/Interstate 515 and Interstate 15 through most of the Las Vegas Valley.

The Valley's freeway system also contains two minor facilities, the Summerlin Parkway and Interstate 2 15 (the Las Vegas Beltway). These highways will become major facilities in the movement of people and goods as they are built out. Currently, the Summerlin Parkway extends from US Route 95,4 miles westward toward the residentially developed northwest Las Vegas (Summerlin area). As this master planned community continues to grow, this facility will be extended further westward thereby providing primary east-west access for its residents.

Interstate 215 is currently a three mile east-west section of the south leg of the Las Vegas Beltway connecting Interstate 15 with McCarran International Airport, with construction currently on-going from Eastern Avenue to Decatur Boulevard. As this facility is built out, it will provide east-west line haul movement connecting southwest Las Vegas and Henderson while maintaining essential access to Interstate 15 and McCarran International Airport. Although no eastern leg is planned for Interstate 215, its completion will provide a circumferential route around the southern, western and northern perimeter of the Las Vegas metropolitan area.

In the Las Vegas Valley there is a heavy reliance on the arterial network to accommodate vehicular travel demand. Consequently, the arterial network plays an essential role in the movement of people and goods. The arterial network in Las Vegas, like many other southwestern cities, has been built around the established system of rectangular survey coordinates yielding a grid network.

The RTC's Regional Travel Demand Model estimates that in 1995, motorists drove approximately 18,530,500 miles per day (VMT = 18,530,500 vehicle miles daily) with a corresponding vehicle hours of travel equivalent to 555,250 hours per day (VHT = 555,250 vehicles hours daily). Systemwide delay is estimated at 12,475 vehicle hours of delay per day. This along with other relevant information for the Las Vegas Valley is summarized in the Table 2.2[1].

[1] Memorandum dated June 14,1996 from DennisMewshaw Regional Transportation Commission to DKSAssociates RE: Las Vegas. Nevada Network Summary

TABLE 2.2: Las Vegas Valley Travel Summary

Vehicle Miles of Travel		18,530,500 vehicle miles/day	
Vehicle Hours of Travel		555,250 vehicle hours/day	
Systemwide Delay		12,475 vehicle hours/day	
Trip Purposes			
	Daily Person Trips	• Home Based Work	22.1 %
		• Home Based School	6.2 %
		• Home Based Shopping	15.4 %
		• Home Based Other	18.2 %
		• Non-Home Based	38.2 %
	Daily Vehicle Trips	• Home Based Work	25.7 %
		• Home Based School	5.4 %
		• Home Based Shopping	14.1 %
		• Home Based Other	16.1 %
		• Non-Home Based	38.8 %
	Vehicle Occupancy Rate	• Home Based Work	1.12
		• Home Based School	1.50
		• Home Based Shopping	1.42
		• Home Based Other	1.45
		• Non-Home Based	1.30

The combination of land development patterns and the arterial network have given rise to several high volume corridors throughout the valley. These corridors are readily recognizable when examining the annual average daily traffic (AADT) volume on the existing system, shown in Figure 2-2.

Figure 2-2 was primarily developed from the 1993 Annual Traffic Report published by the Nevada Department of Transportation (where available, more recent count data was utilized). In reducing the data, it is apparent that several facilities are not adequately represented in the traffic count report. As a result, the Regional Transportation Commission in cooperation with NDOT, have recommended that additional count locations be added to the existing count stations. Figure 2-3 shows the existing and recommended traffic count locations in the Las Vegas Area.

2.3 Recurring and Non-recurring Congestion

2.3.1 Freeways

A significant increase in vehicular traffic has resulted from the unprecedented levels of growth in the Las Vegas Valley, volumes now exceed the capacity of the existing freeway facilities during peak periods. The result is recurring unstable traffic flow characterized by "stop and go" traffic at specific locations along these facilities. Identification and elimination of these "bottlenecks" would decrease overall fuel consumption and corresponding vehicular (mobile sources) emissions along the freeway corridors. Application of ITS should, therefore, focus in these problem areas. Figure 2-4 shows the locations of recurring freeway congestion.

2.3.2 Arterials

The Valley's arterial system is established on a one-mile grid network. The efficiency of this grid network has become degraded due to the high vehicular demand to travel both north-south and east-west, resulting in the formation of "traffic demand barriers." During peak periods, the result is substantial recurring congestion at several intersections along the traffic demand barrier." Figure 2-4 also shows the locations of recurring arterial congestion, as reflected by experience of the Steering Committee members. As illustrated, Las Vegas Boulevard represents one such "traffic demand barrier" where high demand for north-south travel, through the resort corridor, inhibits east-west travel effectively dividing the valley in half. The problem is compounded by the close proximity of, and the limited number of arterial grade-separations with the Union Pacific Railroad and I-l 5. With the opening of Desert Inn Super Arterial in March 1996, this barrier is expected to ease.

Non-recurring congestion, by its very nature, is difficult to pinpoint valley-wide. Accidents, break-downs, cargo spills, and other random incidents are the cause of non-recurring congestion. The duration and severity of this type of congestion is typically a function of the demand on the facility, the type of incident, geometrics of the facility, and the emergency response time. Although there is no realistic way of eliminating non-recurring congestion, the ability to quickly respond and clear an incident from a given

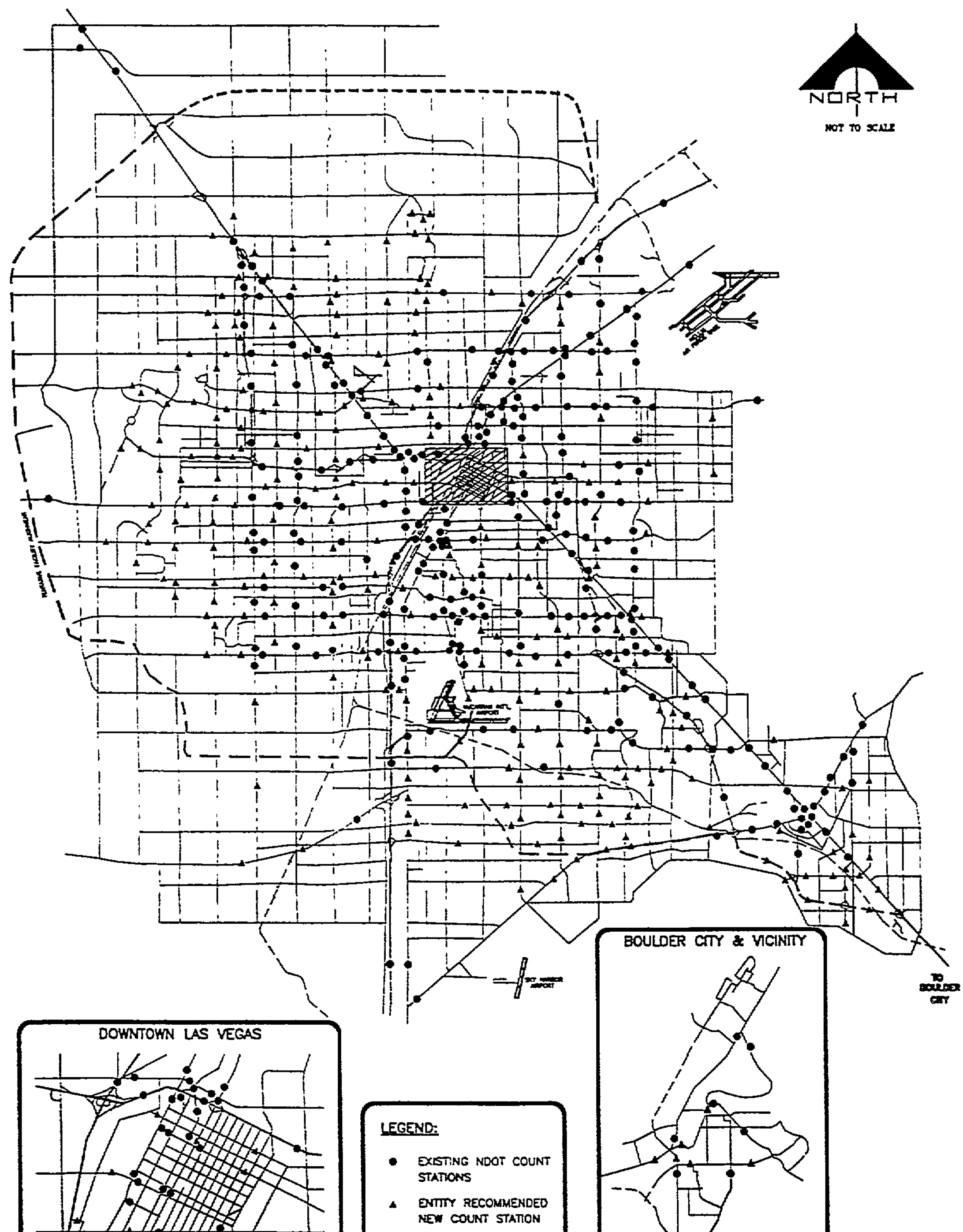

Figure 2-3
Traffic Detection Locations

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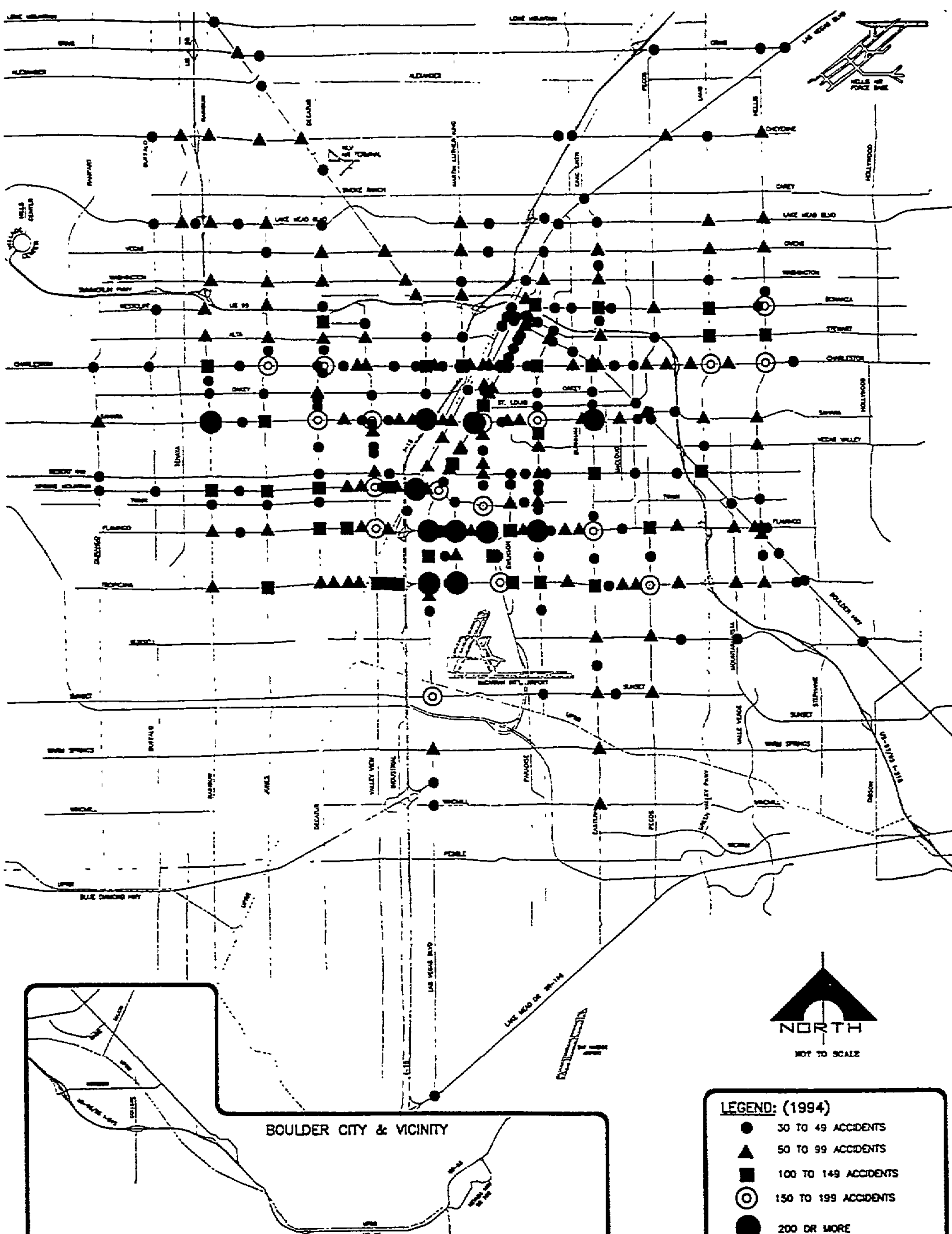

Figure 2-5
1991-1994 High Accident Locations

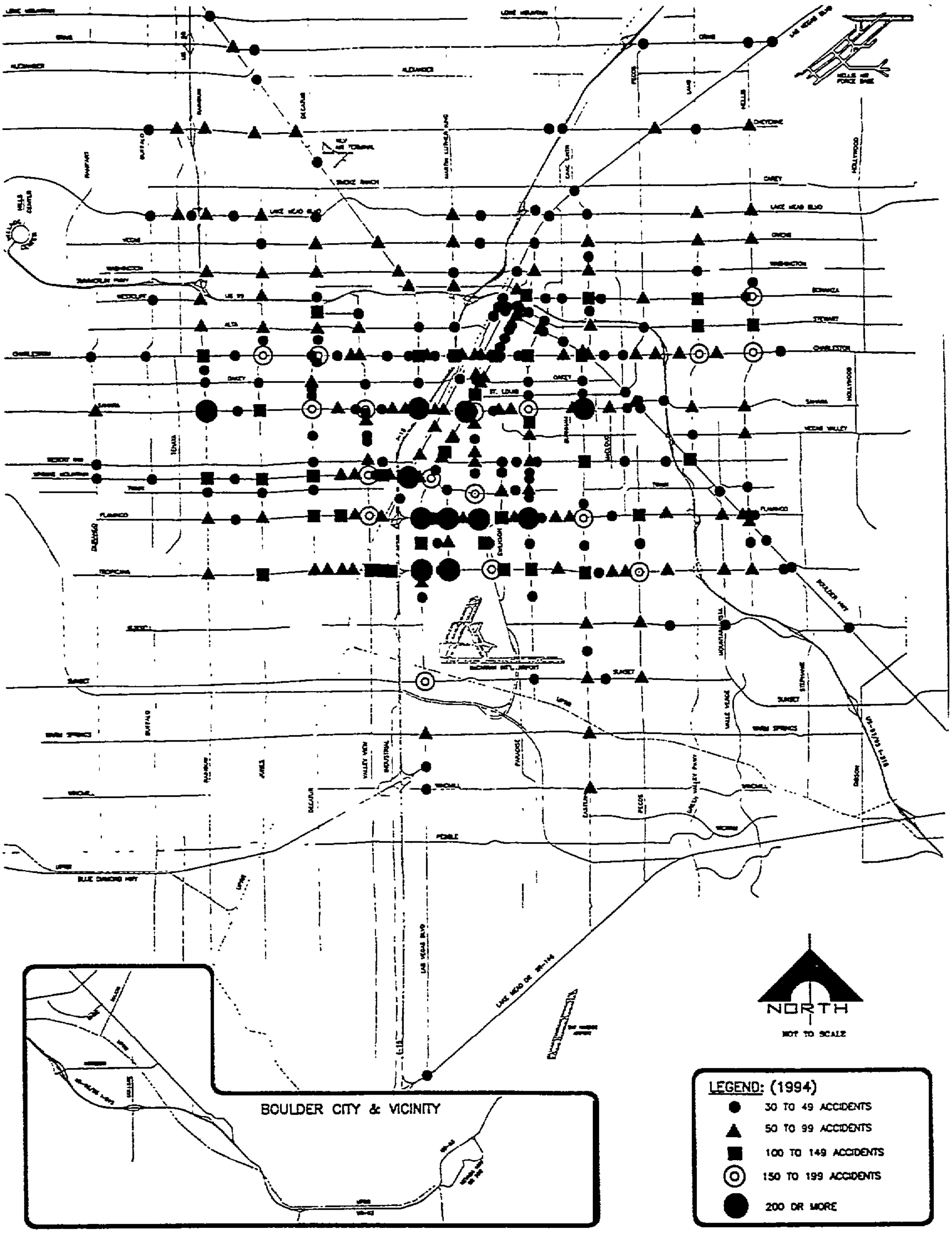

Figure 2-5
1991 -1 994 High Accident Locations

facility will reduce overall traffic impacts. Figure 2-5 depicts those intersections with the highest number of accidents in the three year period from 1991 to 1994.

The focus of an effective incident management program is to minimize the impact of a given incident on the transportation network. Intuitively, an incident at a high volume location is more likely to have a detrimental impact on the surrounding transportation network than a similar incident at a low volume intersection. With this in mind, it is logical to concentrate on those locations with both high traffic volumes and a high number of accidents.

According to Metropolitan Police statistics, there were 7,401 injury and 16,836 non-injury accidents on the surface streets of Las Vegas reported in 1994. The 1994 total of 24,237 accidents represents a 45 percent increase over the total number of accidents reported in 1991 and a 12 percent increase over those reported in 1993. More accidents occurred on Friday (18.4%) than any other day of the week in 1994. Also, more accidents occurred from 5:00 PM to 6:00 PM (9.7%) than any other time of the day in 1994. It should be noted that the interval from noon to 6:00 PM accounted for approximately 48% of all accidents last year. Although the total number of accidents has risen markedly from 1991 to 1994, no sound inferences can be made regarding the relative safety of the roadway system without examining the accident rates.

According to the City of Henderson Police Department statistics, there were a total of 1486 accidents in 1994 and 1692 accidents in 1993. This represents a 14% decrease in total accidents from 1993 to 1994. Similar statistics from the City of North Las Vegas shows a total of 22 10 accidents in 1994 which represents a 13% increase from a total of 1955 accidents in 1993.

In an attempt to better service incidents around the Las Vegas Valley, the Nevada Highway Patrol has initiated a new response program. The program, which takes advantage of the substantial cellular phone ownership in the Las Vegas Valley, relies on drivers to report accidents and incidents immediately after they occur by dialing *NHP on their cellular phone. The call is free to the cellular customer and should result in reducing the response time of the Nevada Highway Patrol.

2.4 Transportation Modes

2.4.1 Air Travel

The distribution of externally based trips that have the Las Vegas Valley as a destination is illustrated in Table 2.3 below. As indicated, personal automobiles are still the most highly utilized mode but air transportation has become more prominent in recent years.

TABLE 2.3: Mode Choice of Visitors Traveling to Las Vegas

Mode of Transport	PERCENT DISTRIBUTION BY YEAR		
	1985	1990	1994
Airlines	38.5%	41.6%	44.3%
Automobile	49.0%	46.8%	46.9%
Bus	12.4%	11.2%	8.5%
Train	0.1%	0.4%	0.3%

McCarran International Airport (LAS) represents the Valley's link with the nation and the world. The importance of MIA to Las Vegas is readily apparent by examining the total number of enplaned-deplaned passengers over the last ten years, shown in Table 2.4.. The airport's passenger totals have more than doubled over the last ten years and the Federal Aviation Administration predicts that those numbers will double again in the coming ten years. By the year 2004, LAS will handle as many passengers as Los Angeles International does today.

TABLE 2.4: Total Enplaned/Deplaned Passengers at McCarran International Airport

Year	Enplaned/Deplaned Passengers	Percent Change
1985	10,924,047	---
1986	12,428,748	13.8%
1987	15,582,302	25.4%
1988	16,231,199	4.2%
1989	17,106,948	5.4%
1990	19,089,684	11.6%
1991	20,171,969	5.7%
1992	20,912,585	3.7%
1993	22,492,156	7.6%
1994	26,850,486	19.4%

LAS's rapid growth has triggered substantial facility improvements as the Clark County Department of Aviation (CCDOA) prepares for the future. Recent completion of the 2.5 mile Airport Connector Road from I-215 will provide non-stop service to MIA from Interstate 15. The Connector has reserved right-of-way for a future mass-transit system. In addition, a new parking garage facility is being constructed that will provide 6,000 short and long-term parking spaces. Completion date of the new garage is anticipated to be November 1996.

LAS employs over 7000 people. The airport currently processes 783 arriving and departing scheduled flights daily. Sunday and Friday are the highest arrival volume days of the week with 20% and 17%: respectively, while Tuesday and Saturday are the lowest with 10% each. The majority of passengers (55 percent) arrive between noon and 6:00 PM. The estimated mode choice distribution for air passengers leaving the airport is shown in Table 2.5.

TABLE 2.5: Approximate Mode Distribution for Air Passengers Leaving McCarran Airport

Mode Choice	Percentage of Arriving Passengers
Passenger Car	52%
Rental Car	20%
Taxi/Limo	14%
Hotel/Motel Shuttle Bus	9%
Other	5%

North Las Vegas Air Terminal, operated by CCDOA, is the general aviation reliever for LAS. It is located north of Carey Avenue and east of Rancho Drive. Besides general aviation services, the airport offers flight training, avionics and aircraft maintenance, and aircraft sales to the Valley. The airport also has significant charter operations.

Sky Harbor Airport is primarily used for airplane tours of the Grand Canyon and various recreational-related aviation activities. The airport provides, among other things, a glider towing service, ultra-light aircraft operations, skydiving, and aircraft storage. CCDOA, in an effort to meet the anticipated future demand for general aviation operations is currently negotiating to purchase the airport to use as a second general aviation reliever for LAS.

2.4.2 Taxicabs

Not surprisingly, the taxicab industry in Las Vegas has experienced tremendous growth over the last ten years as indicated in Table 2.6. There are currently seven taxicab owners owning fourteen taxicab companies, with 740 cabs providing service to the Las Vegas Valley. Table 2.7 provides a breakdown of the total number of trips, total revenue, and total number of vehicles by company for 1994. It should be noted, McCarran International Airport only accounted for 11.2 percent of the total taxicab trips in 1994.

With the growth in the taxicab industry, the operators appear to have a meaningful commitment to providing quality service to the riding public. An overwhelming 93 percent of the visitors who used a taxi while in Las Vegas said they were satisfied with the service they received.

TABLE 2.6: Yearly Taxicab Trips and Revenues

Year	Trips	Percent Change	Revenue	Percent Change
1985	7,306,024	---	$43,353,831	---
1986	7,641,708	4.60%	$50,875,189	17.35%
1987	8,319,195	8.87%	$56,808,695	11.66%
1988	8,498,399	2.15%	$58,037,262	2.16%
1989	8,557,894	0.70%	$59,580,946	2.66%
1990	9,622,631	12.44%	$66,991,603	12.44%
1991	9,490,714	(1.37%)	$69,314,580	3.47%
1992	9,711.755	2.33%	$73,334,161	5.80%
1993	10,569.912	8.84%	$82,569,560	12.59%
1994	13,629,007	28.94%	$107,244,686	29.88%

The large fleet size of taxicabs in Las Vegas offers planners an opportunity to use them as vehicle probes. Since each taxi is already equipped with two-way radio, they can quickly report incidents and traffic conditions to a regional traffic management center. This can be a valuable source of real-time travel information.

2.43 Rental Cars

The demand for rental cars in the Las Vegas Valley is extremely high due to the number of annual visitors that choose to fly into Las Vegas as a vacation destination. Preliminary estimates place the number of auto rentals at approximately two million annually. Based on the 1994 average length of stay of 4.0 days, average party size of 2.7, and that Friday through Monday account for 64 percent of the total arrivals in Las Vegas, it is estimated that one in every 50 vehicles in the Las Vegas Valley is a rental vehicle. This represents a significant number of unfamiliar drivers on the Valley’s roadways. It offers an opportunity to deploy route guidance technology to assist the visitors to find their routes. The large rental car fleet sizes also offer opportunities to deploy in-vehicle navigational devices.

TABLE 2.7: Taxicab Industry Statistics for 1994

Company	Total Number of Cabs	Total Trips	Total Revenue
Ace	66	1,193,820	$9,369,056
Union	56	1,010,413	$8,035,089
Vegas-Western	39	737,596	$5,782,940
A NLV	39	357,467	$3,178,744
Yellow	113	2,068,899	$16,111,332
Checker	113	2,045,341	$16,071,254
Star	41	780,553	$6,129,282
Whittlesea	101	1,936,988	$15,094,491
Henderson	40	795,876	$6,121,888
Western	43	828,682	$6,636,602
Desert	42	874,026	$7,166,868
Nellis	39	899,390	$6,978,305
Lucky	5	95,671	$516,912
TOTAL	**740**	**13,629,007**	**$107,244,686**

2.4.4 Public Transit

The Las Vegas Valley's first publicly-owned/operated mass-transit system, Citizen's Area Transit (CAT), began operations in 1992. CAT currently operates 171 buses and is carrying over 2.7 million passengers per month. The system, which provides service 7 days a week, currently runs 20 hours (from 5:30 am to 1:30 am) in the residential areas of the Valley and 24 hours along the Strip and downtown. The fixed-route bus network consists of crosstown lines that utilize the arterial grid network, radial routes that extend along three major corridors, and resort corridor routes.

CAT offers a new paratransit service which provides on-demand transportation for those with disabilities that preclude them from utilizing the CAT fixed route service. The CAT

Paratransit service consists of 80 buses that will provide over 200,000 passenger-hours of curb-to-curb transport.

2.4.5 Intercity Rail Travel

Trips made to and from the Las Vegas Valley by passenger train (AMTRACK) account for only a small percentage of the overall number of trip ends. Nevertheless, train travel is a viable option for approximately 85,000 people annually. Ridership numbers for Las Vegas over the last five years is provided below.

Year	Ridership
1990	85,861
1991	82,020
1992	84,406
1993	81,769
1994	85,475

2.4.5.1 Intraurban Fixed Guideway

People mover systems of various technologies continue to be considered as viable modes of transport. The future of these light rail and fixed guideway systems in the Las Vegas Valley is currently under investigation in a Resort Corridor Major Investment Study being conducted by Regional Transportation Commission. The results of their analysis will be incorporated into this report at the time of publication. The monorail system currently connecting the MGM Grand Hotel and Casino with Bally's Resort should provide insight into the future of such systems along the resort corridor.

2.4.6 Non-Motorized Mode

The Bicycle/Pedestrian Element of the Regional Transportation Plan an additional element of the sub-regional planning process managed by the Regional Transportation Commission. It is intended to further integrate bicycle and pedestrian facilities with street and highway projects. The ultimate goal is to provide the Valley with greater opportunities for non-motorized, non-polluting forms of transport. The proposed regional bicycle network connects the areas where people live to the areas where they work, shop, go to school, and socialize.

The private vehicle is still the key mode of transport throughout the Las Vegas Valley and will likely continue to be in the foreseeable future. As a result, the existing system is sensitive to the perceived driver level-of-service. One of the most easily perceived measures is speed, or its inverse, travel time. Drivers are keenly aware of the amount of time it takes for them to reach their destination. On freeway facilities, speed is the most evident measure of service quality, while on surface streets, the driver is more sensitive to the total travel time. To this end, Figure 2-6 depicts the current permanent speed loops located on the freeway facilities in the Las Vegas Valley. The figure also illustrates major at-grade railroad crossing locations across the Valley which can induce significant surface street delays.

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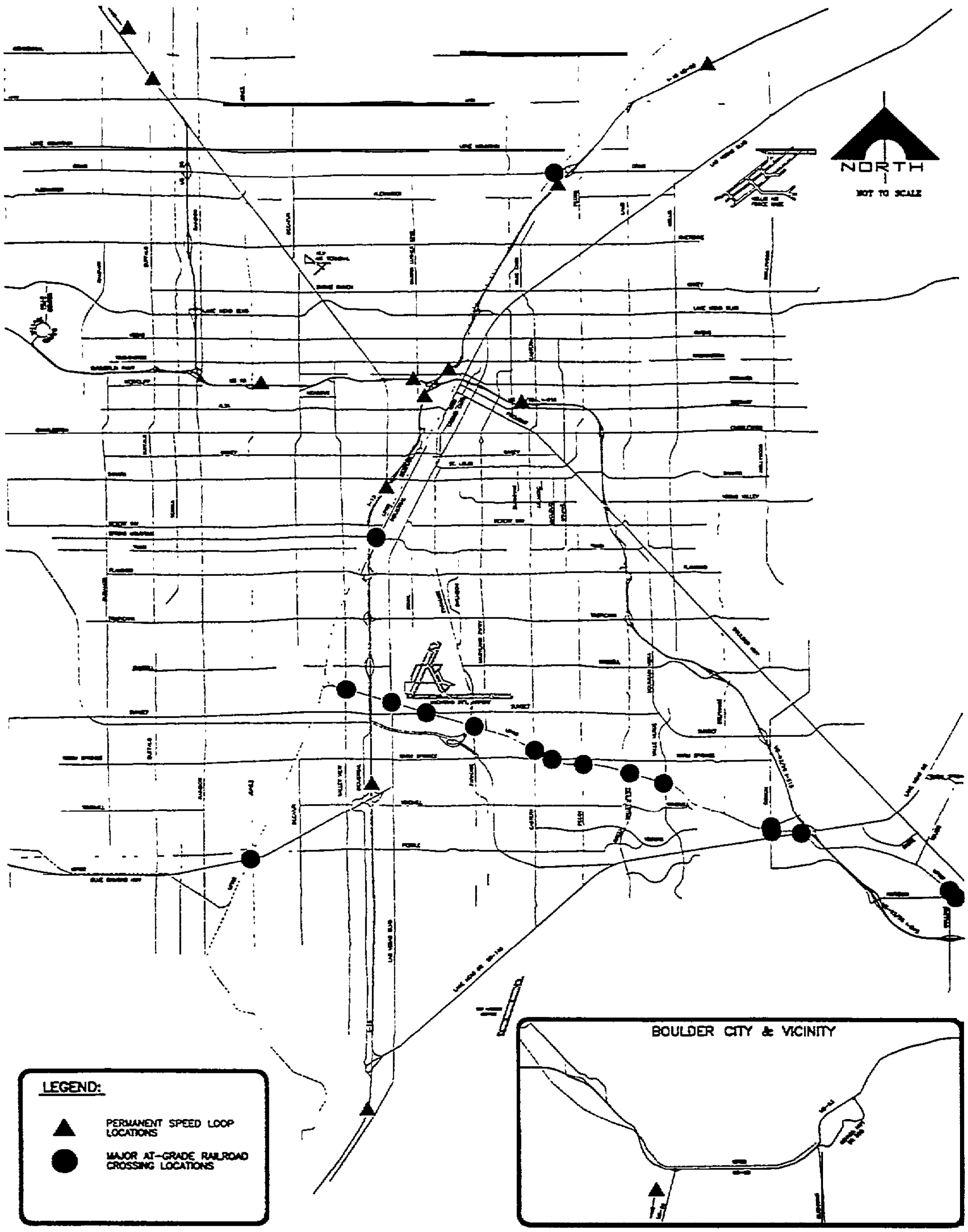

Figure 2-6
Speed Detection Locations
and Railroad Crossings

2.5 Transportation Corridors

The Las Vegas Valley has been divided into transportation corridors. For this study, a corridor is defined as:

> *a distinct transportation service area with multi-modal features including freeways arterials and transit services.*

The following transportation corridors have been identified for this study. Grouped according to directions, these corridors are listed in Table 2.8 below and shown in Figure 2-7. These corridors carry significant amount of traffic in the region and should be given priority considerations for ITS implementation.

TABLE 2.8: Transportation Corridors

NORTH-SOUTH CORRIDORS	EAST-WEST CORRIDORS
• Interstate 15	• US 95 (9 mile east-west section)
• US 95/I-515	• Lake Mead Drive
- Fremont Street /Boulder Highway	• Sunset Road
- Las Vegas Boulevard (Resort Corridor)	• Russell Road
• Rainbow Boulevard	• Tropicana Avenue
• Jones Boulevard	• Flamingo Road
• Decatur Boulevard	• Spring Mountain Road
• Paradise Road (Airport to Conv Center)	• Desert Inn Road
• Maryland Pkwy (Russell Rd to Downtown)	• Sahara Avenue
• Eastern Avenue/Civic Center Drive	• Charleston Boulevard
• Nellis Boulevard (Tropicana Ave to Craig.)	• Lake Mead Boulevard
• Rancho Drive	• Cheyenne Road
• Valley View Boulevard	• Craig Road

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Figure 2-7
Transportation Corridors

2.5.1 North-South Corridors

1. The **Interstate 15 corridor** runs from Southern California to Salt Lake City, Utah and provides the major north-south line haul movement through the Las Vegas Valley.

2. The **US 95/I-515 corridor** provides the primary northwest-southeast line haul movements through the Valley. For this study, the US 95 corridor is divided into the US 95/I-5 15 corridor and the US 95 (east-west) corridor.

3. The **Fremont Street/Boulder Highway corridor** starts at Las Vegas Boulevard and runs southeast into Boulder City.

4. The **Las Vegas Boulevard corridor,** (the Resort Corridor) starts at Lake Mead Drive and extends north to Flamingo Road and northeast to I-515.

5. The **Rainbow Boulevard corridor** extends from Blue Diamond Highway to Westcliff Road/ US-95.

6. The **Jones BouIevard corridor** from Tropicana Avenue to Rancho Drive.

7. The **Decatur Boulevard corridor** runs from Tropicana Avenue to Rancho Drive.

8. The **Paradise Road corridor,** connecting the McCarran International Airport to the convention center, starts at Russell Road and ends at St. Louis Avenue near Las Vegas Boulevard.

9. The **Maryland Parkway corridor,** which runs from Russell Road to the Fremont Street.

10. The **Eastern Avenue /Civic Center Drive corridor,** extending from SR 146 (Lake Mead Drive) to Cheyenne Avenue.

11. The **Nellis Boulevard corridor,** from Craig Road to Tropicana Avenue.

12. The **Valley View Boulevard corridor,** which runs from Flamingo Road to Washington Avenue.

13. **Rancho Drive** is a major “north-south corridor,” running diagonally from US-95 towards Bonanza and southerly towards Sahara. It can serve as a major detour route for the US-95.

14. **I-215 (Beltway) corridor** would become a major circumferencial freeway/ expressway corridor in the region when it is built.

2.5.2 East-West Corridors

1. The **US 95 East-West corridor** starts from Ann Road and extends to the I-15 interchange, including a branch segment of Summerlin Parkway to I-2 15.

2. The **Lake Mead Drive (SR 146) corridor,** runs from the I-15 interchange to Boulder Highway

3. The **Sunset Road corridor,** from Las Vegas Boulevard to Boulder Highway

4. The **Russell Road corridor** runs from Paradise Road east to Boulder Highway. It provides the main access from the eastern part of the Valley to McCarran Airport. In the near future, its connections at Las Vegas Boulevard South and I- 15 will be able to serve westerly with its underpass of the UPRR line and extensions to Decatur Boulevard and then further west to Rainbow Boulevard.

5. The **Tropicana Avenue corridor,** runs from El Capitan to Hollywood Avenue.

6. The **Flamingo Road corridor,** extends from Durango Drive to Stephanie Road.

7. The **Spring Mountain Road corridor,** starts at Durango Drive and ends at Maryland Parkway.

8. The **Desert Inn Road corridor,** extends from Haulpai Way to Boulder Highway, with a “super-arterial” segment across I-15 and the strip.

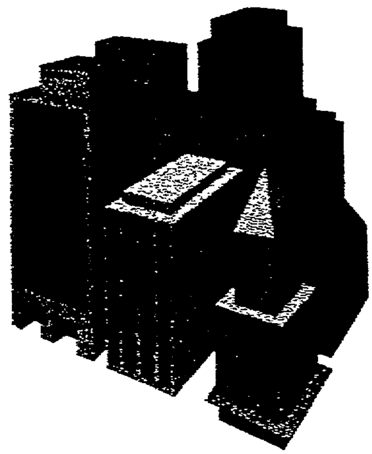
9. The **Sahara Avenue corridor,** starts at Haulpai Way and ends at Hollywood Avenue.

10. The **Charleston Boulevard corridor,** from Haulpai Way to Hollywood Avenue.

11. The **Lake Mead Boulevard corridor** runs from I-21 5 to Hollywood Avenue.

12. **The Cheyenne Road corridor** runs from I-21 5 to Nellis Boulevard.

13. **The Craig Road corridor** runs from US-95 to Nellis Boulevard.



CHAPTER 3
HIGH PRIORITY PROGRAMS

3. HIGH PRIORITY PROGRAMS

The Las Vegas ITS Strategic Plan working groups conducted workshops in November 1995 and March 1996 to identify project concepts which would address the ITS needs of the region. As a result of these workshops, project concepts were prioritized into four categories. These categories are presented in Table 3.1. A description of all the project concepts considered by the working groups is presented in the Appendix.

TABLE 3.1: Priority Categories

• High Priority	- Should be implemented in the near term (1-5 years)
• Moderate Priority	- Should be implemented when funding is available (5 - 10 years)
• Private Sector Lead	- Need to identify private sector interests in leading ITS development
• Low Priority	- Drop from further consideration

Subsequently, the ITS project concept priorities were approved by the RTC Operations Subcommittee (i.e. the ITS Steering Committee), the RTC Executive Advisory Committee, and the high priority project concepts were approved by the RTC Board. The summary of the project concept rankings are shown in Table 3.2.

This chapter discusses the high priority project concepts. Each project concept becomes a program area, and detailed projects, phases, activities and their costs are segregated and discussed in sections 3.1 to 3.8 respectively. Cost estimates provided in these sections are intended for budgetary purposes, and were derived from similar project experiences in other states. The capital costs would allow for construction, procurement, software development, engineering, system design and system integration costs, plus a 10% contingency. The operation and maintenance costs would include staffing costs, operating expenses, maintenance costs and cost of replacement equipment and spares.

TABLE 3.2: Program Area Priorities

- High Priority	1. Regional Traffic Management Center 2. Freeway Management System 3. Incident Management System 4. Service Patrol on Freeways 5. Cable TV Traveler Information System 6. Automatic Incident Detection on Freeways 7. Accident Investigation Sites on Freeways 8. Transit Information System
- Moderate Priority	1. Adaptive Signal System 2. Trailblazer Signs 3. Transit Priority in LVACTS 4. Traveler Information on Internet
- Private Sector Lead	1. Smart Shuttles 2. Airport Traveler Information System 3. Kiosks 4. Personal Data Assistants 5. Rental Car Navigational System 6. Resort Corridor (and other major attractors) Signing System 7. Private Transit/Taxi Probes 8. Smart cards
- Low Priority	1. Railroad Arrival CMS 2. 1-800-COMMUTE! 3. Bus Stop Warning Signs

This chapter addresses mostly the high priority program areas. The moderate priority and private sector lead projects, with the exception of "Trailblazer Signs", will be discussed in Chapter 7. "Trailblazer Signs" are considered among the high priority programs here because it is an integral part of the freeway management system and the incident management system.

3.1 Regional Traffic Management Center

Purpose: Facilitate the regional coordination of traffic control, traveler information and incident management.

Project Background and Need: A Regional Traffic Management Center (TMC) provides a coordinated "nerve center" to integrate existing and future advanced transportation systems implemented within the Las Vegas Valley. Currently, Las Vegas Area Computer Traffic System (LVACTS) operates about 250 traffic signals in the valley. This center can be expanded into a Regional TMC that operates all traffic signals and freeway management systems, and provide a centralized location for collection of weather, traffic, roadway and environmental data for processing and dissemination to other information providing systems. In addition, the TMC could coordinate traffic management functions during incidents with emergency response providers and traffic management personnel in the field.

Las Vegas Valley Application: The Las Vegas Regional Traffic Management Center (TMC) will build upon the inter-agency cooperative funding agreement which has established LVACTS, to expand its functions to include freeway management, traveler information and traffic management during incidents. The TMC will be the central nerve center for enhanced communications among the various agencies to develop and maintain effective traffic management strategies. A conceptual floor plan for the Regional TMC is shown in Figure 3-l. It should be noted that this is only a conceptual floor plan to show the functions, and is not intended to be an architectural layout plan.

The TMC will expand the existing LVACTS center by including facilities for the following:

- Freeway Operations
- Incident Management
- Traveler Information

The traveler information database can be used to provide traveler information to the public or to the private sector "information service providers" to build upon and "sell" to the public. For example, kiosks can be located in the resort corridor to provide traveler information operated by the private sector. See also Chapter 7 for private sector roles.

Staffing needs for the above mentioned functions may be as follows:

Freeway Management

- Need 1 to 3 additional staff, possibly NDOT
- Manager, system engineer and operator

Incident Management

- Need 1 additional staff from NHP

Traveler Information

- Need 1 to 3 additional staff, plus media people
- Manager, system engineer and operator

Activities and Costs - The project activities and costs for the Regional Traffic Management Center are summarized in Table 3.3.

TABLE 3.3: Project Activities and Costs
Program Area: 3.1 Regional Traffic Management Center

Project		COSTS (IN $1000) Transportation Related Capital	% Hwy	% Transit	Annual O&M
1.0.1	**Expand LVACTS to include Freeway Management System**				
Activities:					
1.0.1.1	Architectural improvements to LVACTS	200	100	0	
1.0.1.2	Additional Staff	0	100	0	200
1.0.1.3	Hardware and Software Improvements in TMC	2000	100	0	200
Project: 1.0.2	**Expand TMC to include Traveler Information System**				
Activities:					
1.0.2.1	Media Activities	50	100	0	10
1.0.2.2	Additional Staff	0	0	0	50
1.0.2.3	Develop Regional Database	1000	80	20	100
Project: 1.0.3	**Expand TMC to include Incident Management System**				
1.0.3.1	Communication with Police	200	100	0	60
1.0.3.2	NHP Staff in LVACTS	0	100	0	50
	Program Area Total	**3450**	**98**	**2**	**680**

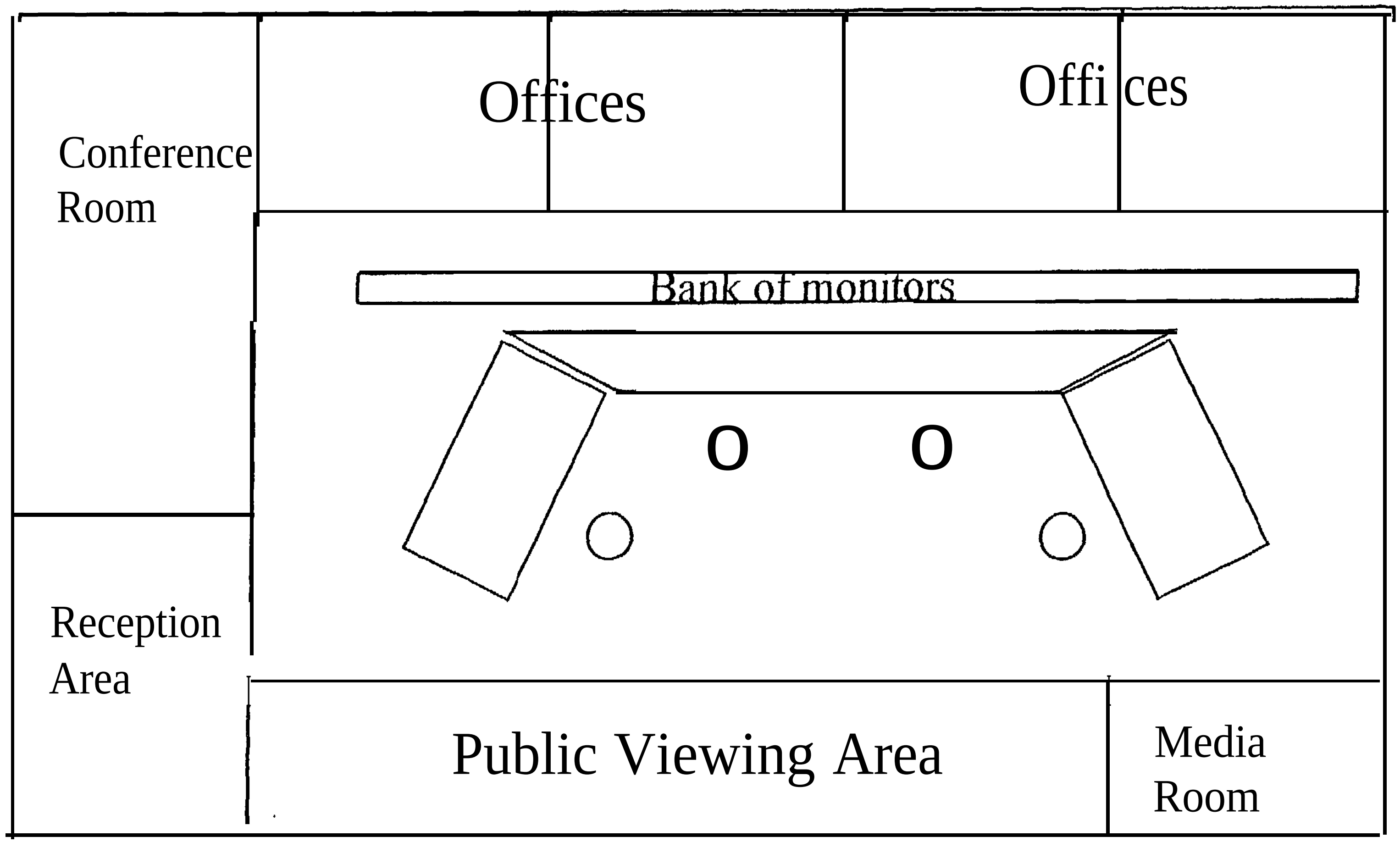


Figure 3-1
Regional Traffic Management Center
Conceptual Floor Plan

3.2 Freeway Management System

Establishing a Freeway Management System provides a cost-effective strategy to facilitate efficient traffic operations on freeways in the Las Vegas Valley. A nine-mile segment of US 95 was selected to be the Pilot Corridor for the Freeway Management System. It is discussed in more detail in Chapter 5.

The Freeway Management System would provide the functions of traffic surveillance and control on all the freeways. The field equipment will include ramp metering, expanded detection, changeable message signs, closed circuit television cameras, highway advisory radio, trailblazer signs, and a communication system. These are further discussed below. The project activities and costs for the Freeway Management System are summarized in Table 3.4. on page 56.

3.2.1 Ramp Metering Systems

Purpose: Ramp metering can reduce freeway congestion by controlling the rate of traffic entering the freeway. It would also have a secondary effect of diverting shorter trips to arterials, thereby reducing overall demand on the freeways.

Project Background and Need: Ramp metering consists of installing devices similar to traffic signal heads at freeway on-ramps. The purpose of the ramp metering is to control the rate at which vehicles enter the mainline freeway, such that downstream capacity is not exceeded. In turn, this allows the freeway to increase the volume carried at a higher speed.

Another benefit of ramp metering is its ability to break up platoons of vehicles that have been released from a nearby intersection. The mainline, even when operating at near capacity, can usually accommodate merging vehicles one or two at a time. However, when groups of vehicles (e.g. platoons caused by an upstream traffic signal) enter the freeway mainline, turbulence and shockwaves are created, causing the mainline flow to breakdown. Reducing the turbulence in merge zones can also lead to a reduction in the sideswipe and rear-end type accidents that are associated with stop-and-go erratic traffic flow.

Las Vegas Valley Application: This program area involves the installation of ramp meters at freeway on-ramps to reduce recurrent congestion as well as accidents. Ramp metering has been shown to have the following benefits:

- Reduction of recurrent stop and go congestion on the mainline freeway improves the air quality by reducing auto emissions generated by vehicles starting from a stop condition. It also reduces fuel consumption.

- Improvement of the average travel speed on the mainline improves mobility. Higher speeds generally result in reduced auto emissions (except for No, and CO).

- Reduction in sideswipe and rear-end type accidents improves safety.

- Increased utilization of transit and other high occupancy vehicles is possible where bypasses of the ramp meters are provided. Typically, the time savings is one to three minutes.

- Discourage drivers from using the freeway for very short trips. Ramp metering is more likely to divert short trips to the arterial streets rather than long trips because the time savings resulting from the improved freeway flow will be smaller (or non-existent) for short trips as compared to long trips.

Ramp metering operates best when the mainline freeway operates close to saturation. Figure 3-2 illustrates a typical speed-flow diagram. At level of service E, close to saturation, the freeway can still operate at a relatively high speed and therefore, high capacity. However, because of the inherent instability of this system, slight disturbances can cause unstable flow, creating slower speeds and lowering the capacity. Ramp metering aims at maintaining the freeway mainline at the stable flow condition by limiting the rate of entry at the ramps.

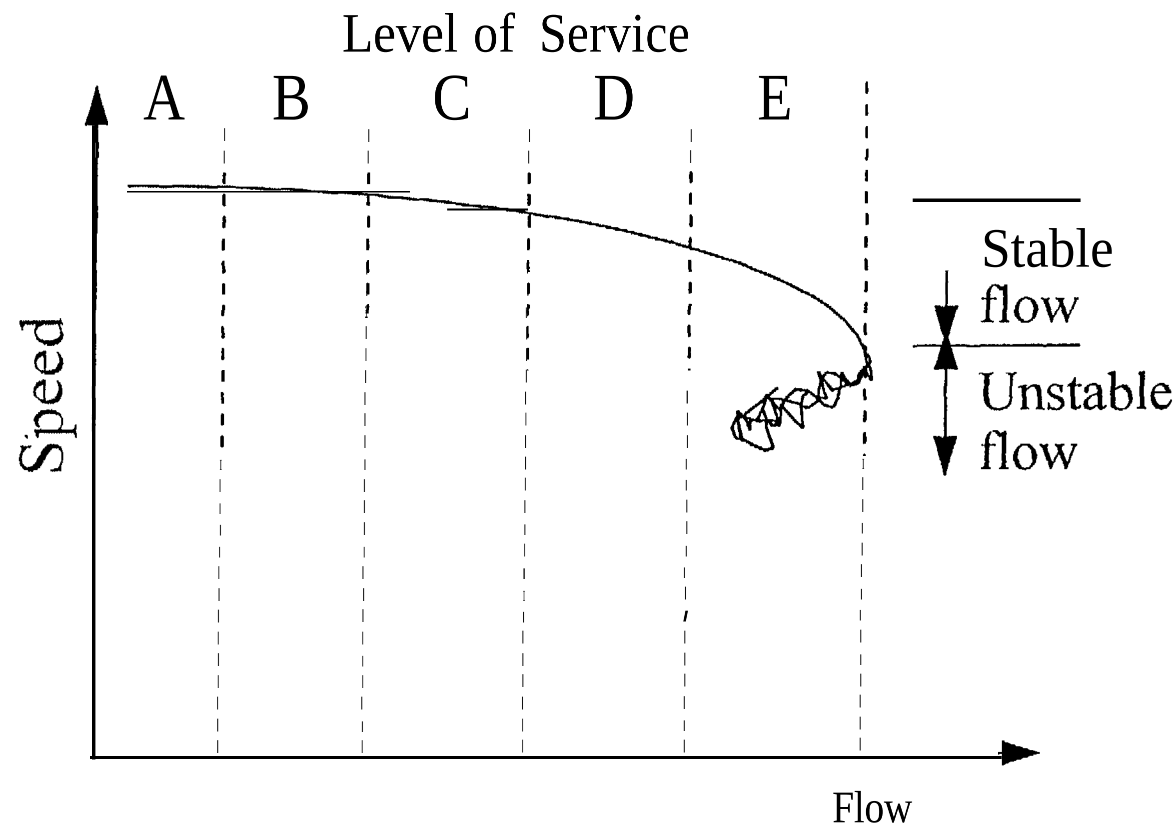
One negative effect of ramp metering is caused by excessive queuing at the ramps. When the demand exceeds the ramp metering rate at a certain ramp, the traffic queue can build up and block an upstream intersection. Figure 3-3 shows this secondary effect of ramp metering. When this happens, two techniques might be deployed. Some agencies provide a queue detector at the end of the ramp to "flush" it before the queue blocks the intersection. However, this sudden increase in demand would create disturbances to the mainline freeway and cause unstable flow, the very situation that ramp metering is intended to avoid. Another technique is to provide positive route diversion guidance to motorists so that they can divert and not enter the ramp. This technique is favored. It can be implemented by “trailblazer signs” as illustrated in Figures 5-14 and 5.15, which is recommended in the pilot corridor.

While this mode of control is used primarily to reduce the impacts of recurring congestion during peak traffic periods, ramp metering can also be implemented to combat incident-related congestion. For example, meters upstream of the incident area would operate at low metering rates, limiting the number of vehicles entering the freeway. Using surface street trailblazer signs and other driver information devices, entering vehicles would be diverted to on-ramps downstream of the incident. These downstream on-ramps would operate with relaxed metering rates (or no metering) to handle the increased demand.

Ramp meter control modes range from pre-timed (i.e., fixed release rates based on a pre-set time-of-day schedule) to local traffic responsive (i.e., rate is calculated in response to traffic flows at adjacent mainline detectors) to system-wide control (optimizing ramp meter rates of all ramps in a corridor to maintain smooth flow through the bottlenecks of the corridor).

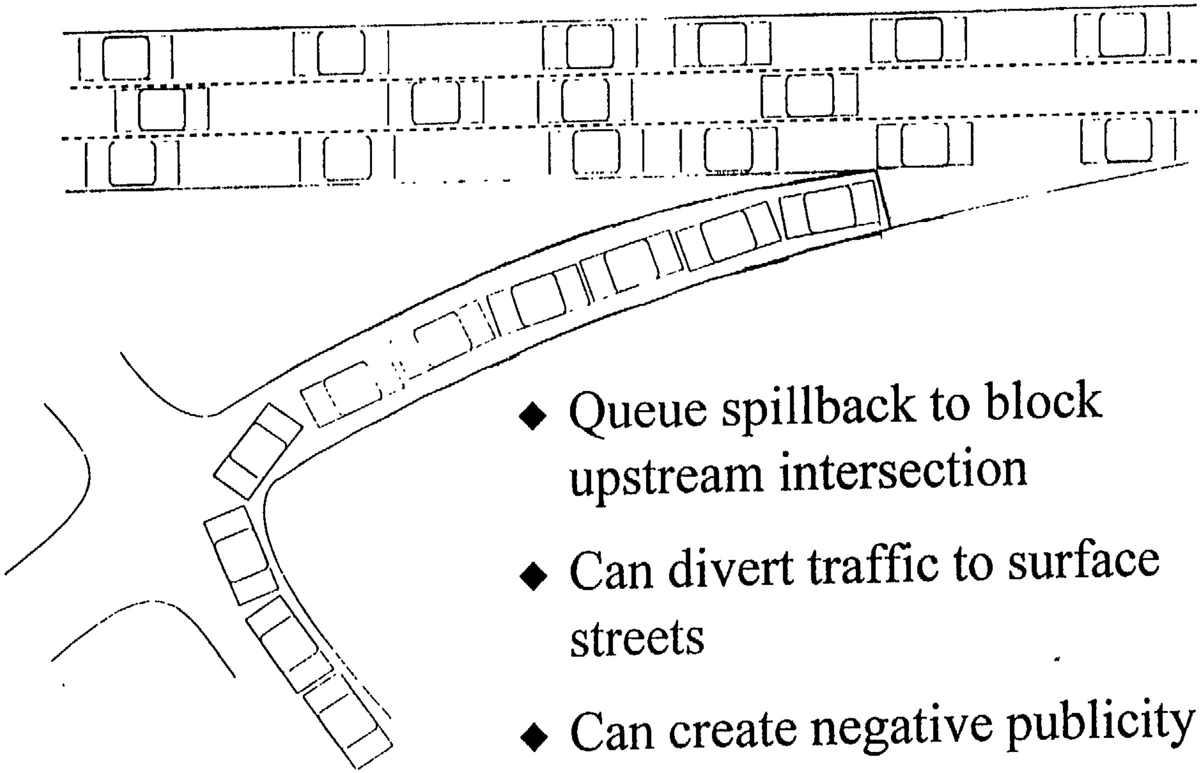
HOV bypass lanes, which are unmetered, may be provided at specific ramps for the use of car-pools, vanpools and buses.

Figure 3-4 shows the proposed locations of ramp meters for the Las Vegas Valley.



- Control the <u>rate</u> of traffic entering a freeway mainline to maintain stable flow

Figure 3-2
Purpose of Ramp Metering



- Queue spillback to block upstream intersection
- Can divert traffic to surface streets
- Can create negative publicity
- Need to provide positive route guidance too

Figure 3-3
Secondary Effects of Ramp Metering

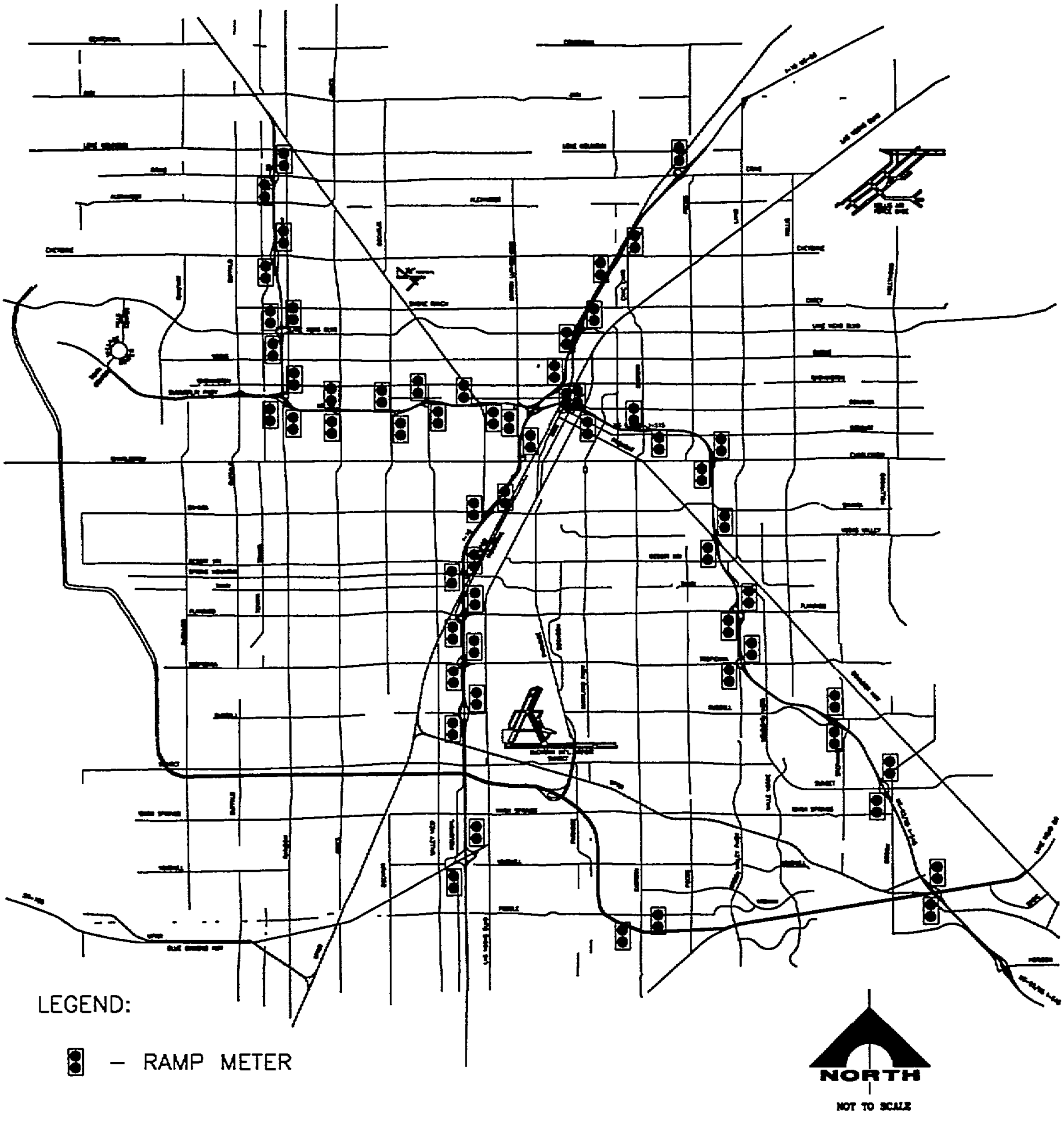


Figure 3-4
Proposed Ramp Meter Sites

3.2.2 Closed Circuit Television Cameras

Purpose: Provide visual surveillance of freeways to observe incidents and traffic conditions through the deployment of closed circuit television cameras

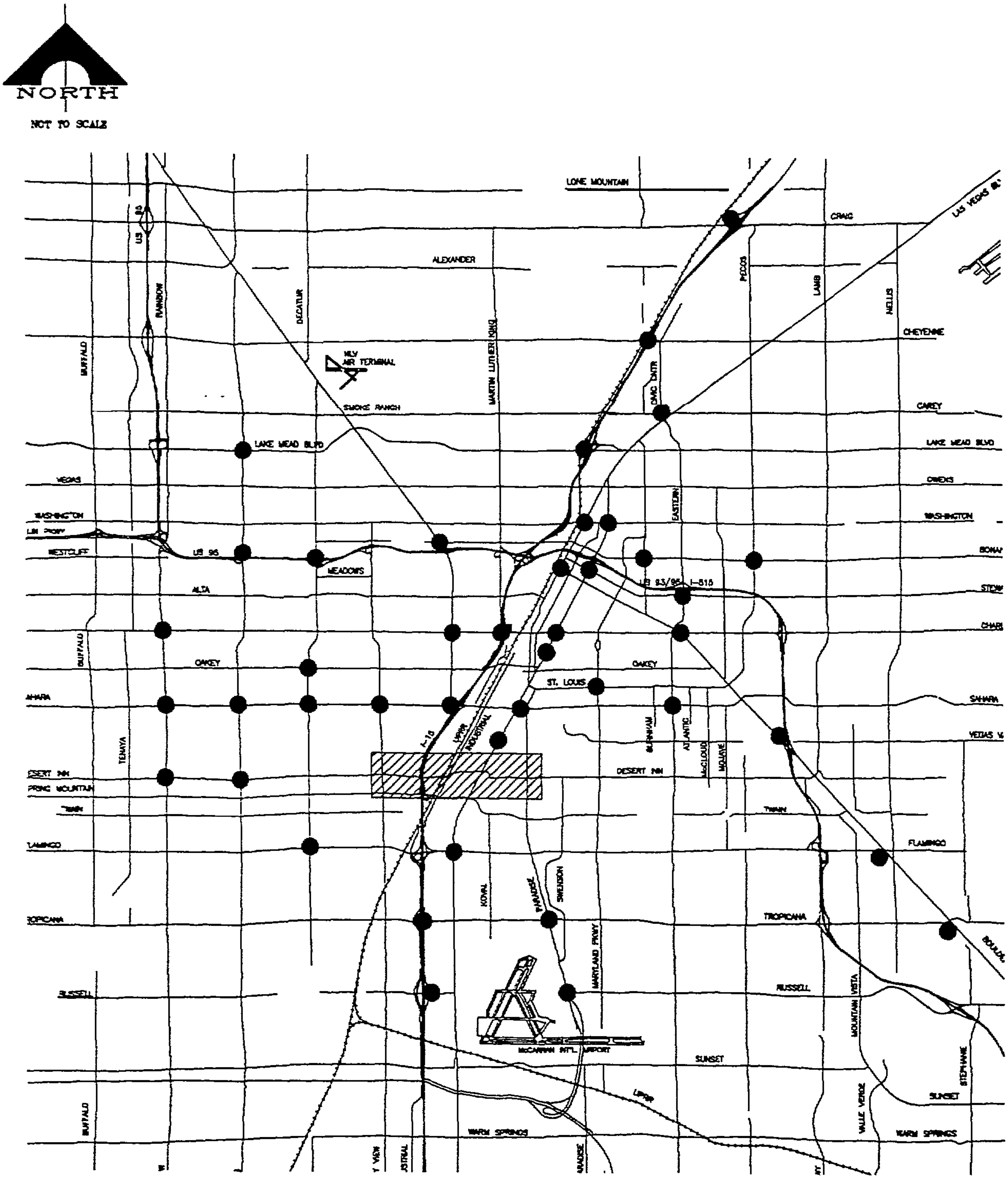
Project Background and Need: Congestion occurs in two forms: recurrent and non-recurrent congestion. Recurrent congestion occurs when the peak period traffic demand exceeds the capacity of the roadway. Non-recurrent congestion occurs when an incident reduces the capacity of a roadway by lane blockage or shoulder activity. Incidents include stalls or breakdowns, debris or spilled loads maintenance or construction activities, weather, special events, or accidents.

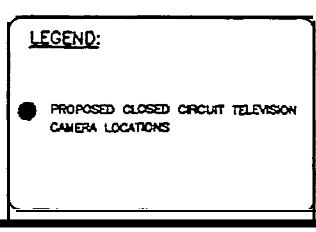
Closed circuit television (CCTV) provides visual confirmation of incidents, and promotes proper responses. Cameras can be linked directly to detection subsystems to automatically activate an alarm and call up the appropriate camera.

Las Vegas Valley Application: This program area calls for the installation of closed circuit television (CCTV) cameras along roadway segments of recurring congestion or high incident locations. Currently, some CCTV cameras are installed on the Desert Inn Super Arterial and inside the Airport Access Tunnel. The LVACTS upgrade project will install about 45 cameras at critical intersections. These locations are shown in Figure 3-5.

The primary purpose of the LVACTS cameras is to confirm traffic conditions and taffic signal operations at intersections. The primary purpose of the CCTV cameras on freeways is to aid in incident detection and verification. Although there may be vantage positions w-hereby both the freeway operations and the adjacent critical intersections are covered, experience in other states indicates that such vantage positions are not easily found, unless the cameras are mounted on top of high rise buildings. Therefore, for the purpose of freeway surveillance, it is assumed that the LVACTS cameras cannot be used.

For full coverage of all freeway segments, CCTV cameras would need to be located at about one mile spacing. Figure 3-6 shows the proposed CCTV camera locations.





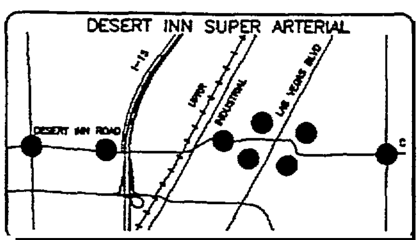


FIGURE 3-5

PROPOSED LVACTS CCTV CAMERA LOCATIONS,

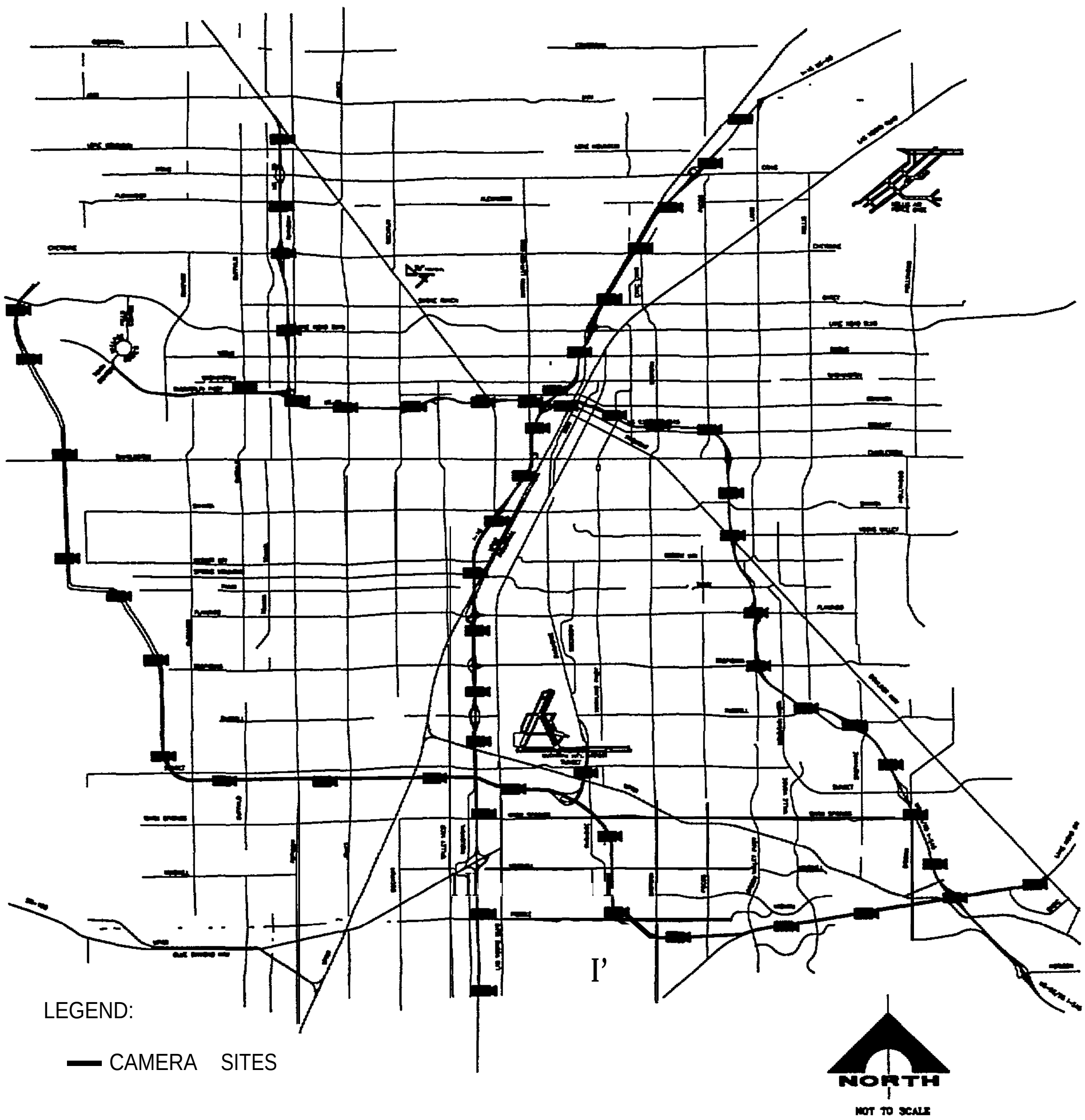


Figure 3-6
Proposed Freeway CCTV Camera Sites

3.2.3 Changeable Message Signs

Purpose:

Changeable Message Signs (CMS) provide current, real-time and changing traffic, weather, and emergency information to the motorist about unusual conditions ahead and advice on possible route alternatives. They are designed to give drivers sufficient notice to take precaution, divert and avoid problems or congestion.

Project Background and Need:

Traffic management agencies across the country have been using changeable message signs (CMS) for years to warn drivers about road construction, weather conditions, traffic congestion and high occupancy vehicle (HOV) restrictions. Motorists would be informed of traffic conditions and could also be advised of alternate routes to take.

Changeable message signs (CMS) can provide dynamic information to motorists regarding a variety of conditions, including:

- *Congestion* - CMS can be used to warn motorists of congestion that lies ahead as a result of an incident, bottleneck or special event. In addition, the CMS can be used to provide warnings when unexpected queuing occurs in areas of restricted sight distance such as around a curve or over a crest.

- *Diversion* - CMS can inform motorists of alternative routes that are available, or that must be taken.

- *General Guidance Information* - directions plus ways to obtain additional information through other media (i.e. radio).

- *Maintenance and Construction Work Sites* **-** CMS can be used to warn motorists of lane closures in progress so that they can avoid abrupt lane changes. End of queue warnings and alternative route information can also be provided to motorists approaching work sites.

Las Vegas Valley Application:

This program area will involve the deployment of changeable message signs (CMS) on freeways in the Las Vegas Valley. Currently, CMSs are installed on the Desert Inn Super Arterial and near the Airport Access Tunnel. CMS offers a technique to provide motorists with real-time traffic information and if desired, alternate route selection advisories in advance of key decision points along the freeways.

For the US 95 Pilot Corridor, changeable message signs can be used to divert traffic away from the US 95 onto the parallel arterials.

CMS systems can be expensive because of the structural and electronic requirements. Hence, they should be integrated with other traveler information dissemination techniques. For instance, NDOT can deploy CMS in conjunction with highway advisory radio (HAR) at key decision points along the freeway. Figure 3-7 shows the proposed changeable message signs locations for the Las Vegas Valley.

At special event sites, CMS can be utilized on surface arterial streets to promote traffic management. Typically, smaller size CMS would be used on arterials.

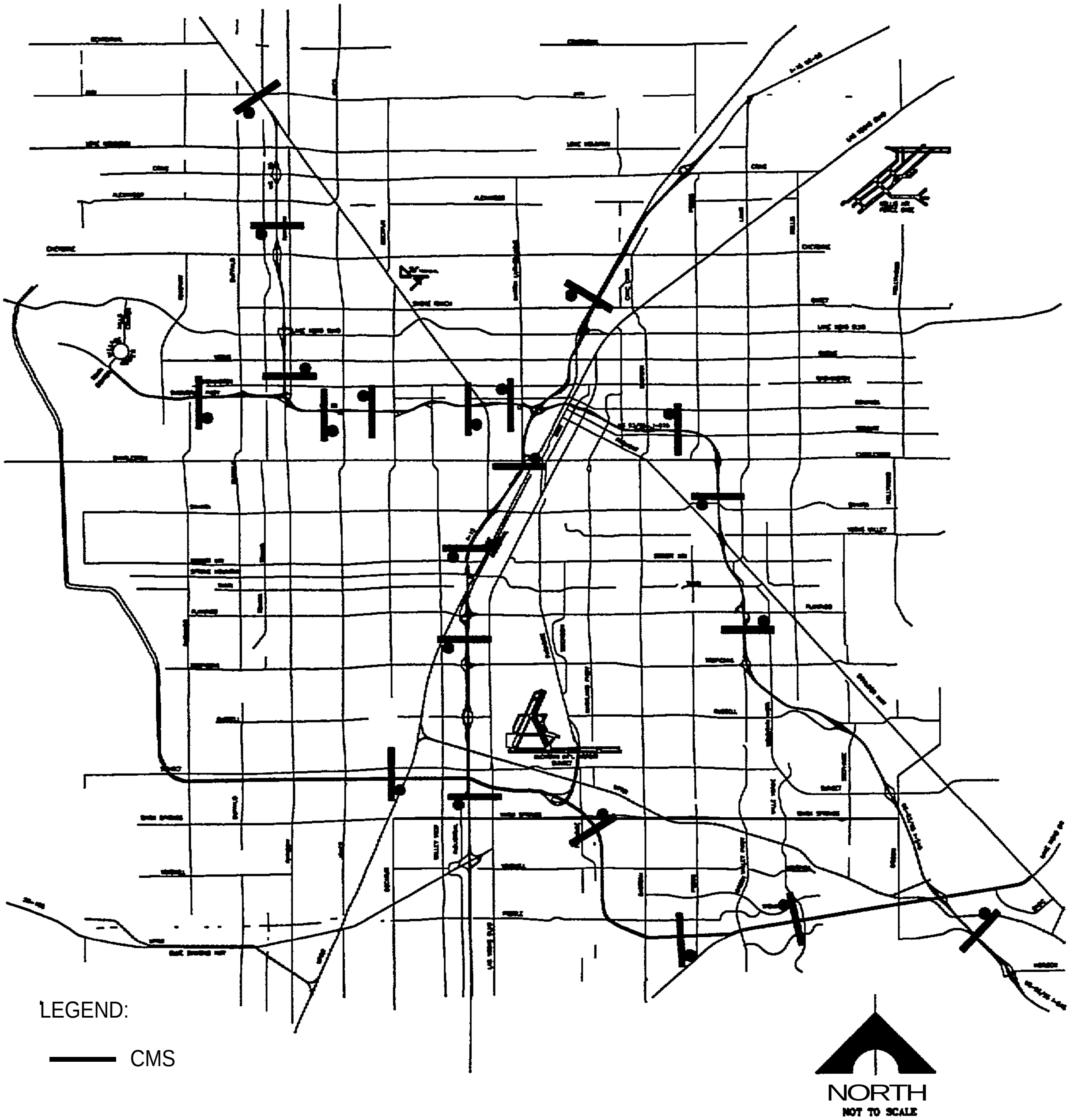


Figure 3-7
Proposed Changeable Message Signs

3.2.4 Highway Advisory Radio

Purpose:

Highway Advisory Radio (HAR) utilizes AM radio frequency to inform motorists of traffic, weather, or other conditions.

Project Background and Need:

The Highway Advisory Radio (HAR) is a short-ranged broadcast sen-ice that provides localized traffic information on road conditions ahead. It serves as an incident management tool by broadcasting conditions such as construction, new routing patterns caused by special area events and warnings of congestion, accidents or stalled vehicles that may results in new traffic patterns. Low powered transmitters along the road provide sen-ice on standard AM radio, which means motorists are not required to buy any special equipment. Depending on the power of the transmission, reception of the broadcast is usually limited to a radius of about five miles. Beacons on fixed message signs are typically used to notify motorists when the HAR is broadcasting and which frequency to turn to.

The HAR transmits localized traffic advisory messages, usually via one of two frequencies adjacent to the standard AM broadcast band (530 kHz and 1610 kHz). Low power radio transmitters are installed along the roadside and broadcast messages specific to a corridor (e.g. "Accident at Lake Mead, congestion next 5 miles.") Drivers must turn their radios to this frequency to receive the messages, but no special in-vehicle equipment is required.

The Los Angeles Smart Corridor project completed testing of the HAR technology in March 1993. The low power transmitters use the 530 kHz AM radio frequency. It has been reported that the HAR performed well during the test. Transmitter range was adequate for their purposes and the system did not suffer interference from local power sources or cellular phones.

In an early test of HAR for rural traveler advisories in Iowa, 5% to 10% of travelers regularly listened to the HAR broadcasts. The listening audience increased to 20% during adverse weather conditions.

Las Vegas Valley Application:

This program area calls for the installation of Highway Advisory Radio (HAR) at strategically selected locations to advise motorists of traffic conditions, traffic detours or alternate routes. The HARs will be located to provide suitable coverage of a corridor or a subregion. Currently, McCarran Airport is broadcasting HAR for airport access information at 530 khz.

The HAR can utilize either live messages, pre-selected taped messages or computer-synthesized voice messages based on the real-time information gathered.

The following features may be considered:

- Live audio traffic bulletins during peak periods.

- A continuous broadcasting option for use during major incidents

- Roadside signs with flashing beacons to advise the motoring public to tune to the HAR service during broadcast.

- Real-time traffic and weather information,

The City of Las Vegas is considering the use of HAR to provide automated real-time information on downtown parking garage vacancies status. This use should be coordinated with the freeway HAR to facilitate maximum utilization of the same channels.

Figure 3-8 shows the proposed highway advisory radio locations for the Las Vegas Valley. The three sites are designed to provide maximum coverage of the region with minimum overlap. The three sites could broadcast different messages for localized traffic information. Besides stationary highway advisory radio, NDOT could procure portable highway advisory radio with lower power antenna mounted on a trailer for incident management use. This procurement can be part of the NDOT emergency response team equipment shown in Table 3.5 discussed in Section 3.3

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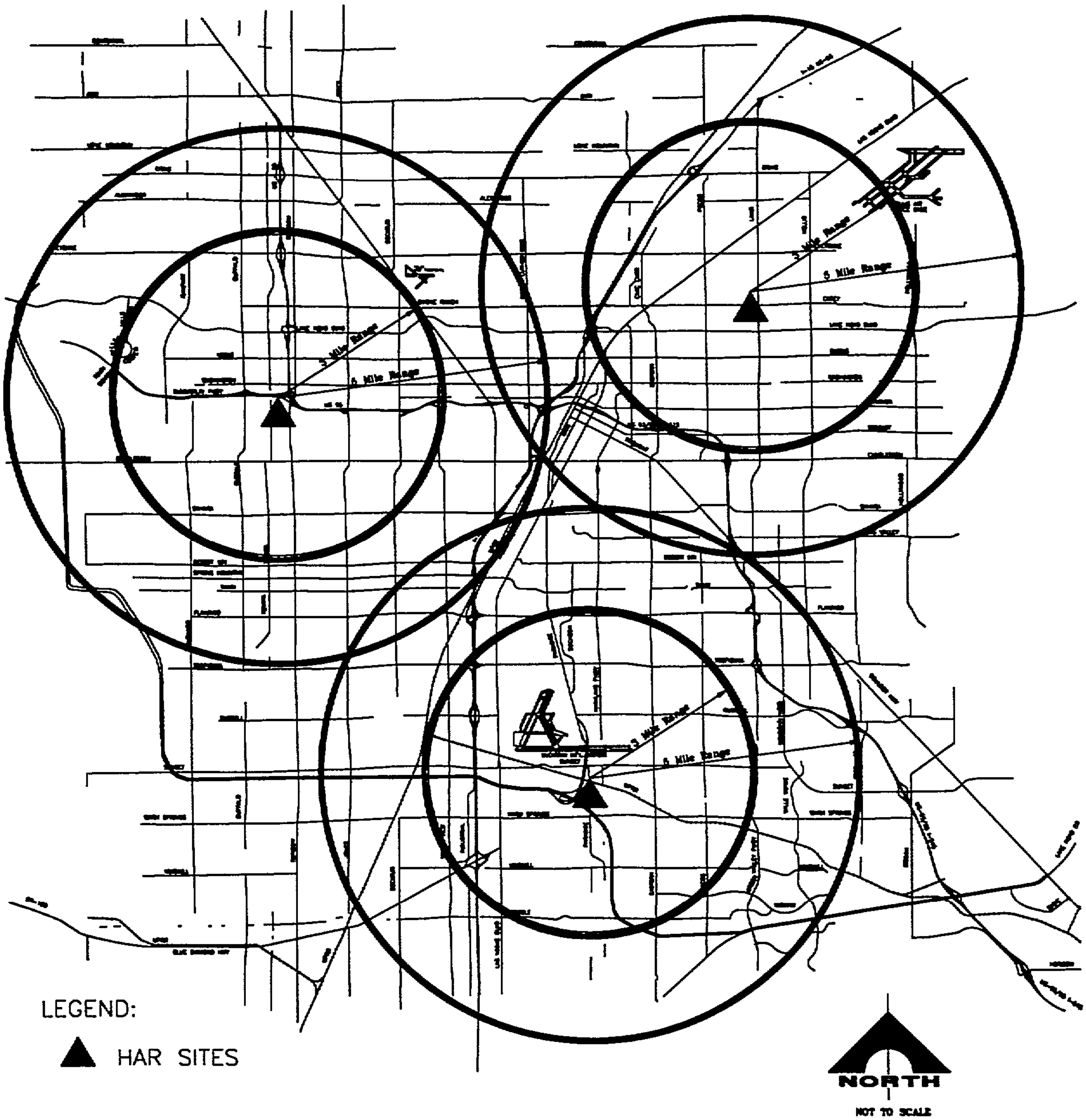

Figure 3-8
Proposed Highway Advisory Radio

3.2.5 Surveillance Detectors

Purpose:

Electronic surveillance detectors collect traffic information for traffic control, traveler information and planning purposes.

Project Background and Need:

Traffic detection systems provide a range of traffic flow information. This information includes speed, volume, density, travel time, queue length, occupancy and vehicle position. These data are used for making traffic management decisions, such as selecting traveler information displays, implementing appropriate control strategies, incident detection, and route diversion. The data may also be stored as a historical record of traffic flow conditions for planning purposes.

Las Vegas Valley Application:

This program area calls for the deployment of a surveillance detection system which would provide real-time traffic information. Many proven detection technologies are available and many more are being developed. This project does not recommend any specific detection technology, since this field is changing so rapidly. Our recommendation is to implement a detection system with the best technology available at that time.

Inductive loop detectors are most commonly used today. Loops can be used to measure volume and lane occupancy and can provide speed and classification (length) information as well. Although loop detector is a proven technology and can provide all necessary detection functions, there have been some concerns about maintenance costs and the disruption of traffic associated with its maintenance. Also, since it is embedded in the pavement, it is not easily portable. Other forms of detection have become increasingly common, among them is the video detection technology.

Video detection involves using video cameras to capture a graphic image of the roadway and video imaging software to determine the presence, occupancy and speed of vehicles. It has undergone rapid development in the past few years and at least five products are commercially available in 1996. One advantage of video detection is that it can be mounted on the roadside on a pole or under an overcrossing, with little interference to traffic during installation and maintenance, and it can be moved from one site to another relatively easily. Another advantage is that the video picture can be transmitted back to the control center for visual surveillance purposes, although visual surveillance would require panning, tilting and zooming the camera picture whereas video detection requires a calibrated fixed detection zone.

Figure 3-9 shows the proposed detection locations on the freeways for the Las Vegas Valley. It should be noted that these detection locations are meant to augment the other detection needs. For example, ramp metering requires providing mainline detectors at interchanges. Traffic signal operations require detectors for vehicle actuation purposes. The detection system recommended here would be used to provide regional traffic information for real-time dissemination or planning purposes.

3.2.6 Communication System

Purpose: A freeway management system relies on a communication system to communicate between the field equipment and the TMC. It is an essential part of the overall system.

Project Background and Need: The field equipment and the TMC needs to have two way data, voice and video communication.

Las Vegas Valley Application: The LVACTS upgrade project will implement a communication framework for traffic signal operations. It consists of fiber optic and copper interconnect cables between intersection controllers, a microwave short-hop between CCTV cameras and the trunk and a 19 Ghz microwave trunk communication back to the center.

For the freeway management system, field equipment such as ramp meter controllers, CMS controllers and CCTV circuits can utilize the microwave trunk for communication back to the TMC. A distribution system is needed to multiplex the different field equipment. Based on experience, it is cost effective to provide a continuous fiber optic network in conduits located at one side of the freeway. This fiber optic network can be connected to the LVACTS microwave hubs. Based on this design, Figure 3-10 shows the freeway communication system. Opportunities exist for the private sector to provide a communication network at no cost through a shared resources arrangement. NDOT would offer the right-of-way for the telecommunication company to provide conduits and fiber optic cables.

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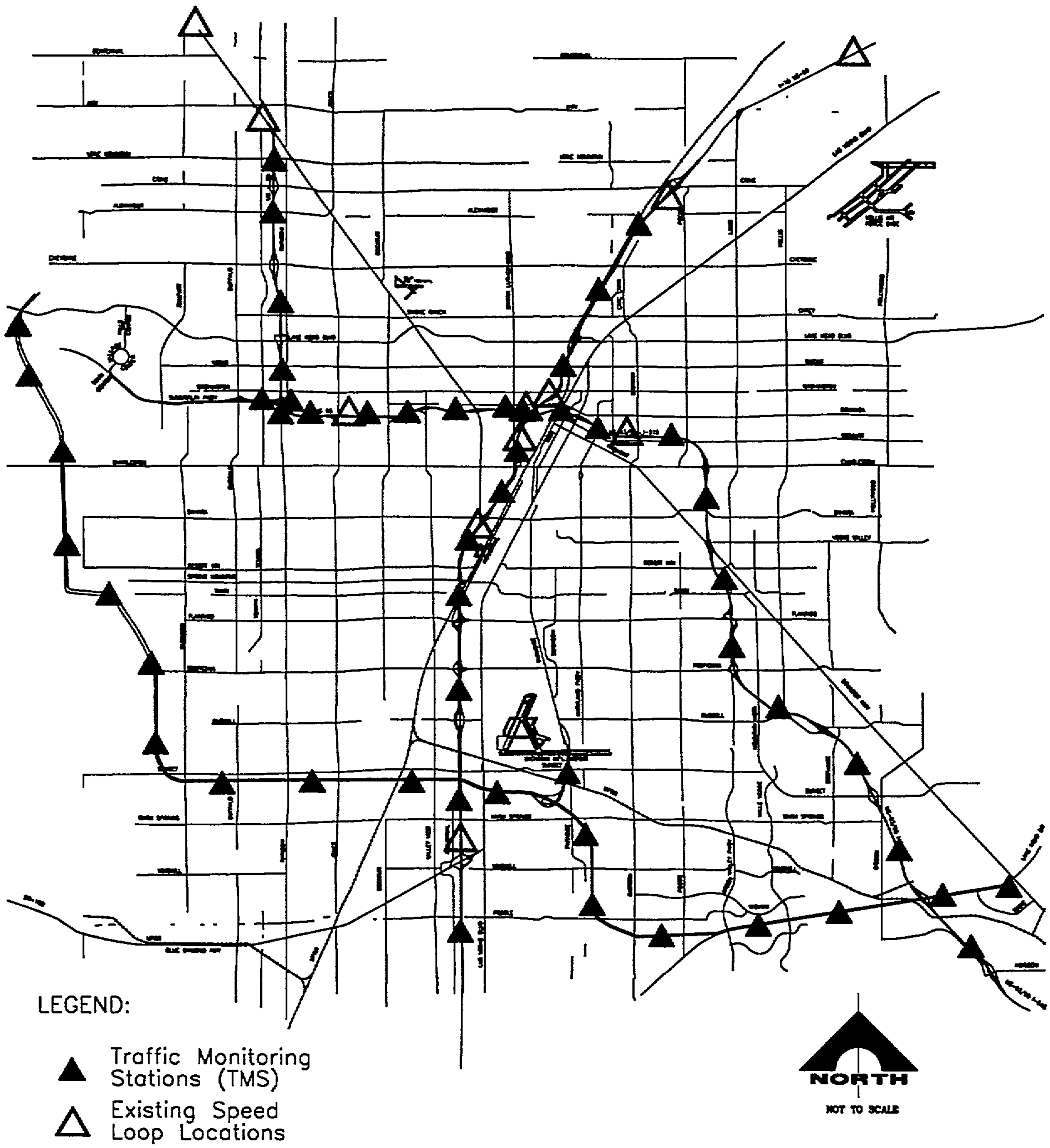

Figure 3-9
Proposed Traffic Monitoring Station

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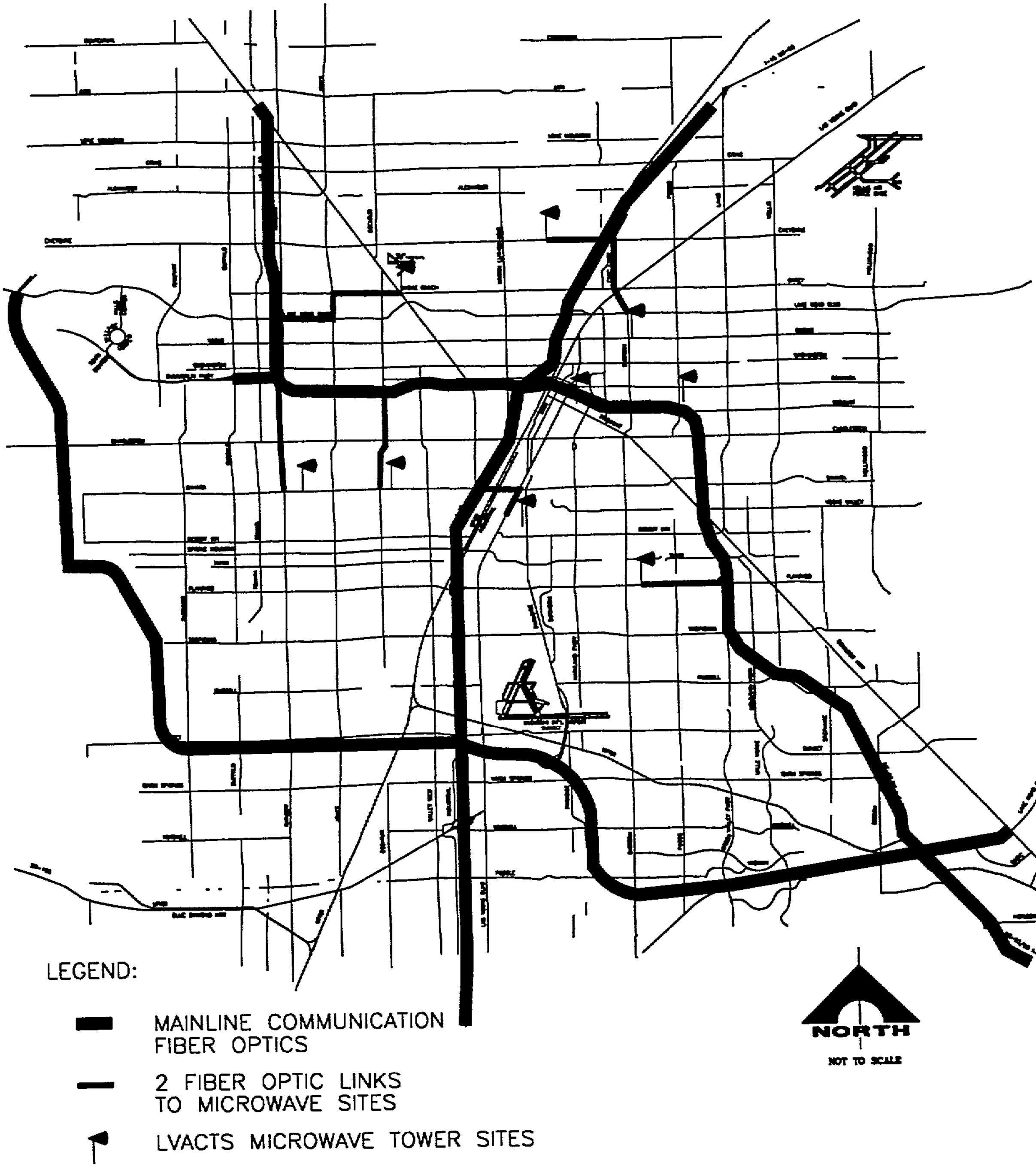


Figure 3-10
Proposed Freeway Communication System

TABLE 3-4: Project Activities and Costs
Program Area: 3.2 Freeway Management System

		COSTS (lN $1000)			
		Transportation Related Capital	% Hwy	% Transit	Annual O&M
Program Area: 2.1	**Ramp Metering System (RMS)**				
	Projects:				
2.1.1	Install initial ramp meter system for US 95	1140	100	0	57
2.1.2	Integrate initial system with freeway management system and LVACTS	360	100	0	0
2.1.3	Expand ramp metering to I-15 and Airport Expwy	1140	100	0	57
2.1.4	Expand ramp metering to us 93/95	1140	100	0	57
2.1.5	Expand ramp metering to Beltway	120	100	0	6
	Total	**3900**			**177**
Program Area: 2.2	**Closed Circuit Television Cameras**				
	Projects:				
2.2.1	Install initial CCTV system for US 95	858	100	0	43
2.2.2	Expand CCTV to I-15 and Airport Expwy	1404	100	0	70
2.2.3	Expand CCTV to US 93/95	1092	100	0	55
2.2.4	Expand CCTV to Beltway	1248	100	0	62
	Total	**4602**			**230**
Program Area: 2.3	**Changeable Message Signs (CMS)**				
	Projects:				
2.3.1	Install initial CMS system for US 95	1728	100	0	86
2.3.2	Expand CMS to 1-15 and Airport Expwy	768	100	0	38
2.3.3	Expand CMS to US 93/95	768	100	0	38
2.3.4	Expand CMS to Beltway	768	100	0	38
	Total	**4262**			**200**

Program Area: 2.4 Highway Advisory Radio (HAR)				
Projects:				
2.4.1 Install initial HAR system for US 95	12	100	0	1
2.4.2 Expand HAR to I- 15 and Airport Expwy	12	100	0	1
2.4.3 Expand HAR to US 93/95	0	100	0	0
2.4.4 Expand HAR to Beltway	12	100	0	1
Total	**36**			**3**
Program Area: 2.5 Detection				
Projects:				
2.5.1 Install initial detection system for US 95	78	100	0	4
2.5.2 Expand detection to I- 15 and Airport Expwy	72	100	0	4
2.5.3 Expand detection to US 93/95	60	100	0	3
2.5.4 Expand detection to Beltway	102	100	0	5
Total	**512**			**16**
Program Area: 2.6 Communication System				
Projects:				
2.6.1 Install initial communication system for US 95	1200	100	0	60
2.6.2 Expand communication to I- 15 and Airport Expwy	2880	100	0	144
2.6.3 Expand communication to us 93/95	1680	100	0	84
2.6.4 Expand communication to Beltway	3120	100	0	156
Total	**8880**			**444**
Program Area: 2.7 Install Trailblazer Signs				
Projects:				
2.7.1 Install initial trailblazer signs for US 95	972	100	0	49
2.7.2 Expand trailblazer signs to I-15 and Airport Expwy	0	100	0	0
2.7.3 Expand trailblazer signs to us 93/95	0	100	0	0
2.7.4 Expand trailblazer signs to Beltway	0	100	0	0
Total	**972**			**49**
Grand Total	**22734**	**100**	**0**	**1119**

3.3 Incident Management System

Purpose:

To improve the efficiency of incident management and traffic management during incidents in the Las Vegas Valley to reduce the negative impact of incidents.

Project Background and Need:

Traffic congestion has become a critical issue for most urban areas. A recent Federal highway Administration (FHWA) study determined that 55 percent of peak urban freeway travel occurred under congested conditions.[2] Another FHWA sponsored study performed by the Texas Transportation Institute concluded that, among the major metropolitan areas in the country, non-recurrent congestion caused by incidents account for over 50% of the total travel delay.

Non-recurrent congestion is caused by lane blockages during incidents. Lane blockages and disruptions of traffic flows typically include:

- major accidents that tie up several lanes or entire freeways for hours
- minor accidents and stalled vehicles that block only one lane for short durations
- vehicle stopped on shoulders
- spilled loads
- construction, utility and maintenance activities
- special events that generate heavy traffic volumes

When lanes are blocked, several events occur: Roadway capacity falls. If it falls below the traffic demand, excess demand volumes are created, and traffic queues are formed. This traffic queue continues to extend upstream in the form of a shock wave. When the blockage is removed, this queue of congested traffic is dissipated over time and normal flows are restored. Depending on the traffic demand, one minute of lane blockage can cause up to 9 minutes of delay before the queue is cleared. The stop and go operation resulting from the lane blockage can further result in secondary accidents.

[2] Lindley, J.A., "Urban Freeway Congestion: quantification of the Problem and Effectiveness of Potential Solutions," ITE Journal, January 1987.

The following table summarizes the typical capacity reduction due to incidents for a three lane (one direction) freeway[3].

Freeway Capacity Reduction Resulting from Incidents

Incident Type	*Capacity Reduction (%)*
Normal Flow (three lanes)	--
Stall (one lane blocked)	48
Non-injury accident (one lane blocked)	50
Accident (two lanes blocked)	79
Accident on shoulder	26

As can be seen, the effect is not linear. The closure of one lane will result in the loss of more capacity than can be provided by that one lane. Even an incident on the shoulder, not physically in a lane, such as a stalled vehicle or law enforcement stop, can cause a 26 percent capacity reduction. The reduction in capacity creates a significant delay to motorists.

Delay not only occurs in the travel direction of the incident but also on the other side of the freeway as evidenced by motorists slowing to observe the incident - the "gawking effect" or "spectator slowing".

Las Vegas Valley Application:

As with any emergency response agency, the needs and requirements of Las Vegas Metropolitan Police (METRO), Nevada Highway Patrol, other local police departments, and the various fire departments focus on public safety and safety of their officers during incident investigation and clearance. There exists a need to integrate this priority into traffic management during incidents. Also, any means of improving incident detection, response, investigation and clearance time will greatly reduce the negative impact on traffic flow.

The Incident Management Workshops conducted in November and March, 1996 identified the following issues:

- Accident investigations require lengthy road or lane closures, especially on the freeway.
- Enforcement officer responding to non-injury incidents may cause a delay in the removal an incident scene.

3 Reiss RA and Dunn W M. "Freeway Incident Management Handbook" FHWA Office of Traffic Operations and IVHS July 1991.

- State law requires coroner to make the determination that a fatal accident has occurred and state the cause. This often delays the incident clearance time of a fatal accident.
- Lack of common communication channel
- Problem of ‘rubbernecking’
- Staffing and equipment needs
- Effective incident detection system
- Insurance and litigation requirements may make operational improvements difficult.

An Incident Management System needs to coordinate all response activities to increase the efficiency of all responsible organizations. The police departments are responsible for incident investigation and clearance. A communication linkage must be made to NDOT and LVACTS to effect traffic control during incidents. To reduce the adverse traffic impacts that an incident has on the system, these agencies must be able to implement suitable traffic management strategies, and safely detour traffic around the scene. The ability to expedite this process is important to these agencies.

The Incident Management Workshops identified the following solutions to the issues identified above.

1. DeveIop pre-planned detour routes
2. Change legislation to allow expeditious clearance
3. Install magnetic strip on Nevada drivers license
4. Change legislation to allow self-reporting of non-injury incidents
5. Establish task force to consolidate accident report
6. Install regional accident database
7. Provide common radio channel and cellular phones for response agencies
8. Provide ‘accident investigation sites’
9. Enhance LVACTS center to become ‘ Incident and Traffic Management Center (ITMC)’
10. Provide METRO staff in ITMC
11. Enhance equipment and Staffing for NDOT emergency response team
12. Provide automated incident detection system on freeways
13. Establish and maintain a standardized milepost system forstate facilities
14. Provide freeway service patrol
15. Install ‘ trailblazer signs’

Figure 3-11 and 3-12 shows the current incident management set-up and the recommended set-up respectively. The public stands to benefit from the establishment of this incident management system in that there can be coordinated emergency/incident response among responsible organizations. This will result in faster response times and a productive and effective use of all agency resources.

Activities and Costs The project activities and costs for the Incident Management System are summarized in Table 3.5.

TABLE 3.5: Project Activities and Costs
Program Area: 3.3 Incident Management System

		COSTS (IN $1000)			
		Transportation Related Capital	% Hwy	% Transit	Annual O&M
Project:					
3.0.1	Develop pre-planned detour routes	100	90	10	5
3.0.2	Change legislation to allow expedition clearance	0		-	0
3.0.3	Install magnetic strip on Nevada drivers license	0			0
3.0.4	Change legislation to allow self-reporting of non-injury incidents	0			0
3.0.5	Establish task force to consolidate accident report	0			0
3.0.6	Install regional accident database	200	90	10	10
3.0.7	Provide common radio channel and cellular phones	1000	90	10	0
3.0.8	Enhance equipment and staffing for NDOT emergency response team	300	90	10	100
3.0.9	Establish and maintain a standardized milepost system for state facilities	25	90	10	0
	Program Area Total	**1625**	**90**	**10**	**115**

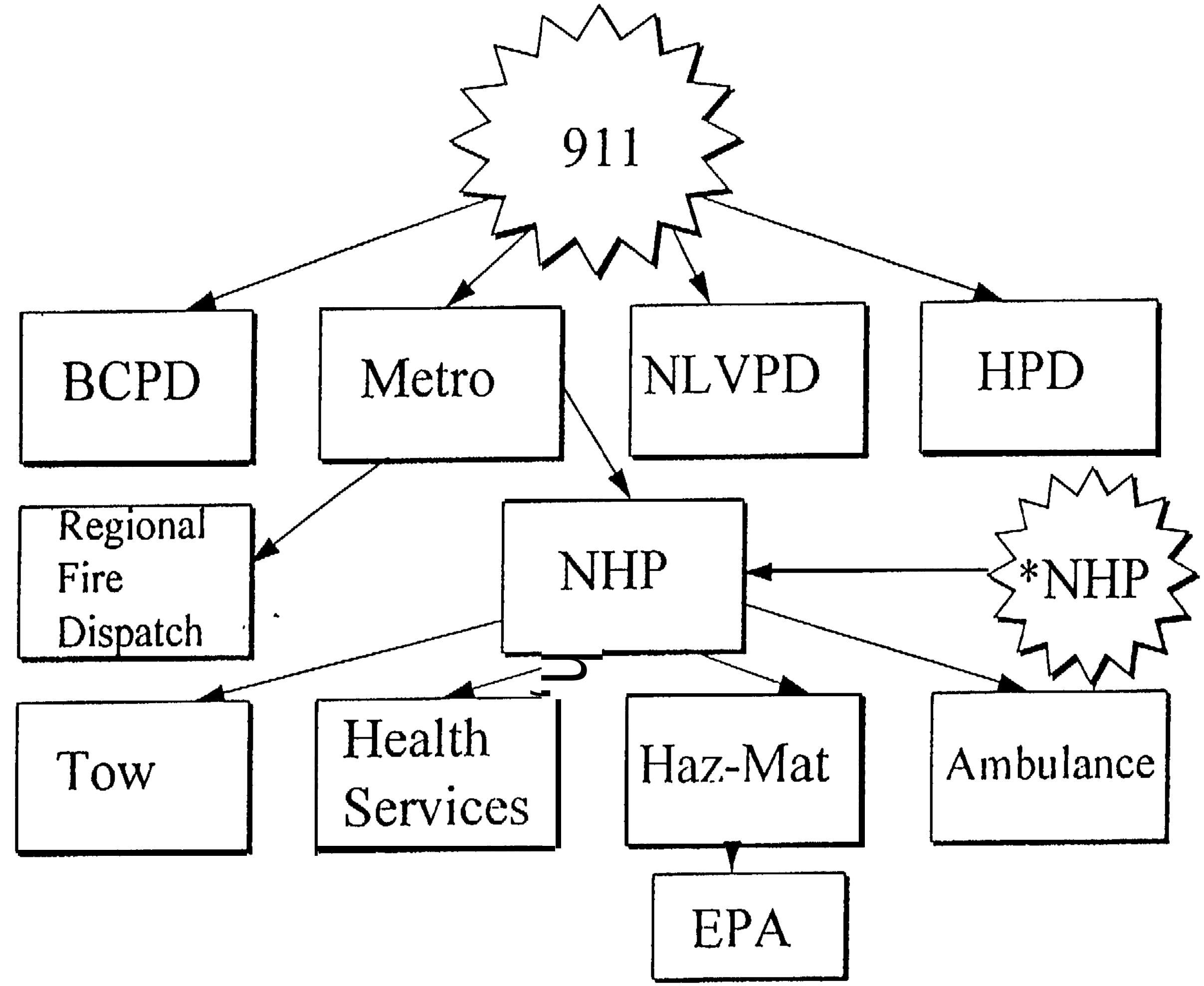


Figure 3-11
Existing Incident Management Setup

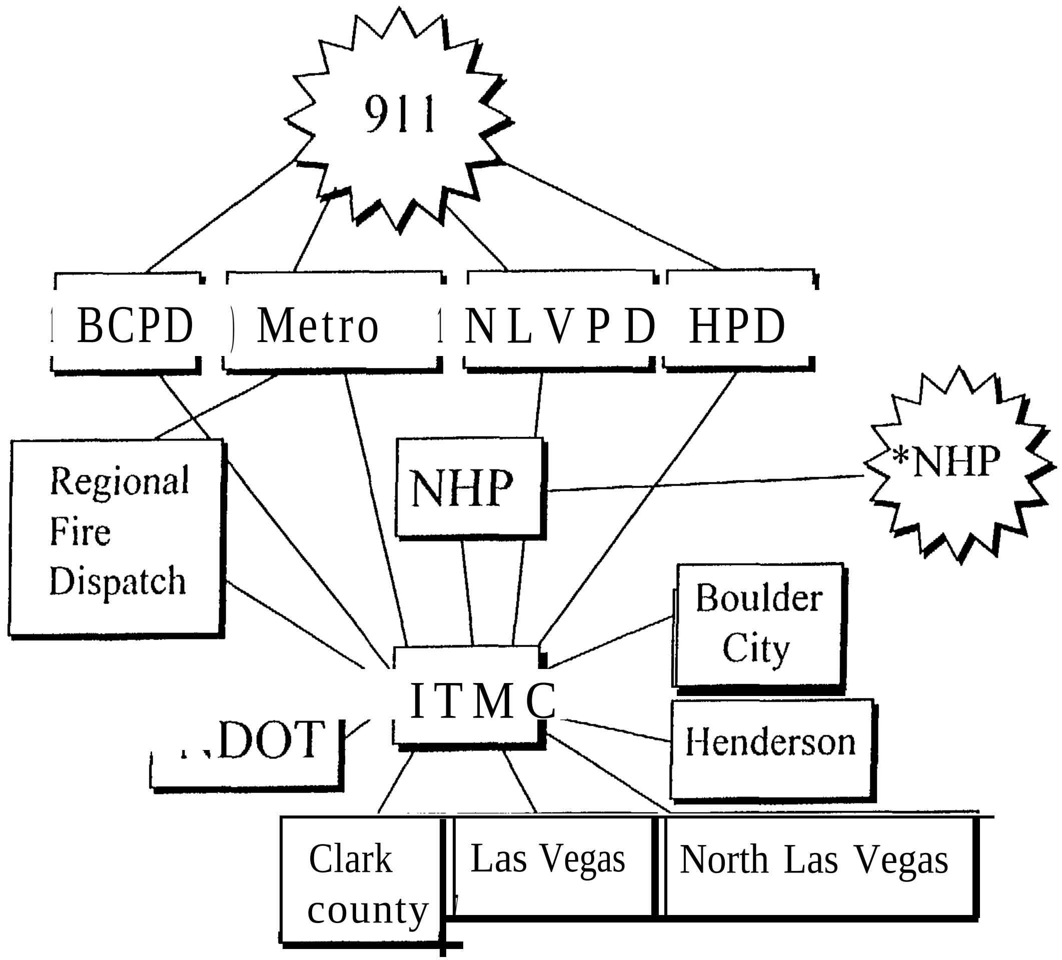


Figure 3-12
Recommended Incident Management Setup

3-4 Service Patrols on Freeways

Purpose

Service Patrols provide roving trucks on expressways to clear disabled vehicles and/or potentially hazardous debris

Project Background and Need:

Freeway service patrols are trucks roving on expressways aimed at clearing disabled vehicles and/or debris. Such programs are in effect in states like Colorado, California and Minnesota. A program can utilize private tow truck operators at a cost of anywhere from $40 to $55 per hour. Assigned to cover a predetermined freeway segment or group of segments (usually between 5 to 10 miles) during patrol, the service patrols are equipped with 2-way communication devices to allow responders to contact emergency (police/fire/medical) help if necessary.

Las Vegas Valley Application:

This program area calls for the establishment of a Freeway Service Patrol (FSP). The FSP will help to identify incidents, clear disabled vehicles and/or potentially hazardous debris from the freeway as soon as possible.

The objectives of the service patrols are to identify incidents, minimize incident duration, restore full capacity to the facility and reduce risks to motorists.

The freeway service patrol can be performed by the public sector or the private sector. To minimize capital costs, our recommendation is to commission this service to private towing companies with full regulation and management by the public sector. The capital costs required in this case would be to procure radio and other equipment to be mounted on the trucks.

Activities and Costs

The project activities and costs for the Freeway Service Patrol are summarized in Table 3.6.

TABLE 3.6: Project Activities and Costs
Program Area: 3.4 Service Patrol on Freeways

		COSTS (IN $1000)			
		Transportation Related Capital	% Hwy	% Transit	Annual O&M
Project: **4.0**	**Service Patrol on Freeways**				
4.0.1	Install service patrols on US 95 peak - private sector	50	100	0	300
4.0.2	Install service patrols regionwide peak - private sector	30	100	0	250
	Program Area Total	**80**	**100**	**0**	**550**

3.5 Cable TV Traveler Information System

Purpose: Cable TV traveler information system provides for easy access to traveler information in homes and hotel rooms through the use of cable television.

Project Background and Need: A traveler information system is an effective ITS tool for reducing congestion, delay, fuel consumption mobile source emissions, and improving safety. This involves informing travelers of real-time traffic conditions, construction zone detours, incident information and airport/airline information.

Cable television is one of the most commonly available household traveler information means. Cable TV companies obtain their franchise from the local jurisdictions. Public agencies can make it part of the franchise agreement to dedicate some channels at no cost to the government for community access use, and a few of these channels can be used for traveler information.

Las Vegas Valley Application: The deployment of a cable television traveler information channel in the Las Vegas Valley would provide commuters with real-time traveler information.

Aside from providing real-time traffic information, construction zone locations and incident information, the Cable TV Traveler Information Channel can include bus transit information as well as airline flight information. Airport users can check the status of their flights from cable TVs in their homes or in hotels before commuting to the airport.

Activities and Costs The project activities and costs for the Cable TV Traveler Information System are summarized in Table 3.7.

TABLE 3.7: Project Activities and Costs
Program Area: 3.5 Cable TV Traveler Information System

	COSTS (IN $1000)			
	Transportation Related Capital	% Hwy	% Transit	Annual O&M
Project				
5.0 Cable TV Traveler Information System,				
Activities:				
5.0.0.1 Develop interface to regional Traveler Information Database	150	80	20	10
5.0.0.2 Provide graphic display & CCTV images to Cable TV	0			15
Program Area Total	**150**	**80**	**20**	**25**

3.6 Automatic Incident Detection and other Motorist Aid Systems

Purpose: To facilitate faster detection and identification of incidents

Project Background and Need: The first step towards reducing the impacts of incident induced congestion is to identify and detect the incidents quickly and verify its location and nature. The traditional means of incident detection relies on users or passer-by samitarians to call in through the telelphone (911). Through call-ins, most major incidents in urban areas are reported within 5 - 15 minutes. Incidents in less travelled rural areas may take longer to detect. To facilitate ease of call-ins, some states have installed motorist aid systems such as call boxes alongside highways.

With the increased use of cellular phones, it has become more and more the predominant means of incident detection. Some states have even experienced excessive calls per incident due to extensive use of cellular phones. However certain incidents, especially in the rural area or areas without cellular coverage, may go unreported for 30 minutes or more[4].

Automatic Incident Detection (AID) and other motorist aid systems aim at reducing the time it takes to detect or report an

4 Cambridge Systematics. Inc. for Trucking Research Institute Final Report: Incident Management. October 1990.

incident, thereby providing quicker response and reducing the impacts an incident would cause.

Las Vegas Valley Application:

In Las Vegas, incident reporting through call-ins has become common place. NHP has already facilitated ease of incident reporting by cellular phones through a *NHP number.

As part of the freeway management system, detectors would be installed on freeways at regular intervals (see section 3.2.5). These detectors provide the ability to monitor traffic and detect changes in traffic flow, speed and occupancy, which can be used to determine the occurence of an incident. An incident management algorithm would monitor this information and raise an alarm in the TMC when an incident is detected. This is the basis of an automatic incident detection system (AID).

Once a disruption in traffic flow is detected, indicating a possible incident, an alarm would be sent to the operator for incident verification. Visual observation is needed to verify the location and nature of the incident. Verification confirms the actual location of an incident (often times different locations for the same incident are reported by the public), and assists in the dispatching of the proper types and numbers of emergency response equipment.

Besides AID, there are other types of incident detection systems geared towards providing motorist aid, such as call boxes. However, with the increased popularity of cellular phones, and since the personal communication technology is undergoing significant changes in the near future, the decision to implement an automatic incident system, as well as any motorist aid systems, are recommended to be postponed in order to allow NHP and NDOT to evaluate the adequacy of incident reporting through cellular call-ins. Therefore, it is recommended that automatic incident detection and motorist aid system be programmed in the later years of the ITS implementation phasing.

Activities and Costs

Based on the assumption of using detectors designed for the freeway management system, and adding detectors where necessary, the project activities and costs for a Freeway Automatic Incident Detection System are summarized in Table 3.8

TABLE 3.8: Project Activities and Costs
Program Area: 3.6 Automatic Incident Detection on Freeways

		COSTS (TN $1000)			
		Transportation Related Capital	% Hwy	% Transit	Annual O&M
Project: **6.0.1**	**AID for US 95 Corridor**				
	Activities:				
c procure 100 90 10 0 6.0.1.1	incident detection algorithm				
6.0.1.2	Install additional detectors on freeways	65	90	10	5
6.0.1.3	Integrate AID into freeway management system	100	90	10	10
Project: **6.0.2**	**MD for I-15 Corridor**				
	Activities:				
6.0.2.1	Install additional detectors on freeways	100	90	10	5
6.0.2.2	Integrate AID into freeway management system	50	90	10	10
Project: **6.0.3**	**AID for US 93195 Corridor**				
	Activities:				
6.0.3.1	Install additional detectors on freeways	120	90	10	5
6.0.3.2	Integrate MD into freeway management system	50	90	10	10
Project: 6.0.4	**AID for Beltway Corridor**				
	Activities:				
6.0.4.1	Install additional detectors on freeways	100	90	10	5
6.0.4.2	Integrate AID into freeway management system	50	90	10	10
	Program Area Total	**735**	**90**	**10**	**60**

3.7 Accident Investigation Sites on Freeways

Purpose: Provide designated safe refuge area for accident investigation.

Project Background and Need: When an accident occurs on a freeway, entrance/exit ramp, or an area adjacent to any freeway, it is desirable to move the vehicles to a suitable location which does not impede traffic. However, there are two impediments to early removal of incidents. Firstly, state law does not allow for removal of accidents without police presence. Secondly, the motorists do not know where they can safely move their vehicles to. An accident investigation site would provide such a safe refuge for motorists to self-remove vehicles involved in an incident and exchange the necessary information.

Accident investigation sites (AIS) are currently being experimented with around the country. They are formally designated and signed areas off the freeway system with easy access from the freeway. These accident investigation sites provide a location for motorists to drive their damaged vehicles off the freeways to the designated area to exchange accident information rather than tie up travel lanes or create traffic speed reductions which substantially reduce the freeway's capacity.

Las Vegas Valley Application: The deployment of accident investigation sites would be advantageous to the Las Vegas Valley freeway system. The construction of pull-outs every one-half to one mile in both directions, or at known high accident areas would provide a safe refuge to clear vehicles and debris from travel lanes. By screening off the accident investigation site from the freeway mainline, police and response teams would be able to safely conduct their accident investigation, allowing traffic to pass. By providing suitable signs and lighting, these pull-outs would also allow safe refuge for motorists to pull off to the roadside, if needed.

Figures 3-13 and 3-14 show typical accident investigation sites.

Legislation may be needed to provide a legal basis for motorists to move vehicles involved in an accident off the freeway to another location. Also, an intensive public information program will be necessary to encourage motorists to use these sites. As the legal and insurance aspects of the use of accident investigation sites needs further analysis, this action warrants further consideration before it can be recommended.

Activities and Costs The project activities and costs for the Freeway Accident Investigation Sites is summarized in Table 3.9

TABLE 3.9: Project Activities and Costs
Program Area: 3.7 Accident Investigation Sites on Freeways

		COSTS (IN $1000)			
		Transportation Related Capital	% Hwy	% Transit	Annual O&M
Projects					
7.0	**Accident Investigation Site on Freeways**				
7.0.1	Accident investigation sites on US 95	300	100	0	0
7.02	Accident investigation sites on I- 15 and Airport Expwy	600	100	0	0
7.0.3	Accident investigation sites on US 93/95	400	100	0	0
7.0.4	Accident investigation sites on Beltway	400	100	0	0
	Program Area Total	**1700**	**100**	**0**	**0**

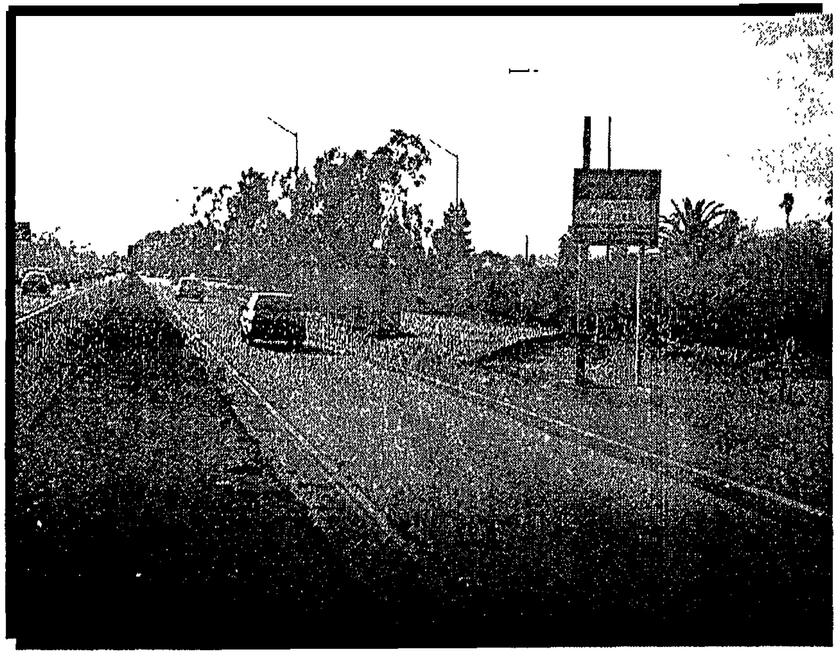
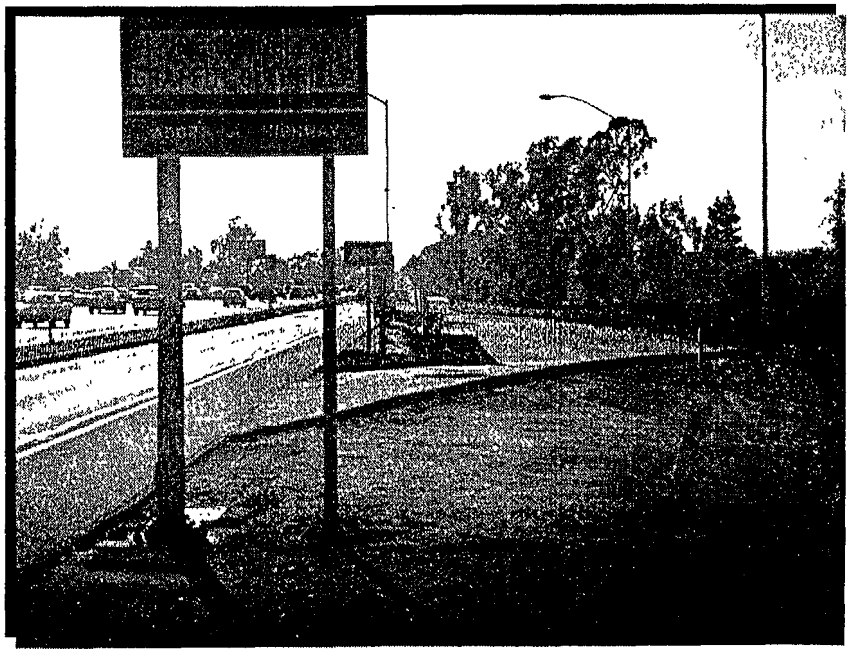
 

Figure 3-13 & 3-14
Accident Investigation Sites

3-8 Transit Information System

Purpose: Provide real-time, accurate transit service information to travelers using public transportation, helping them make effective transfer decisions and itinerary modifications as needed either before they begin their trip or while it is underway. Other means of promoting transit operations including transit priority and "smart card" to facilitate ease of payment and transfer should also be included.

Project Background and Need: Transit providers are typically concerned with customer service parameters such as schedule reliability, headways, waiting times, passenger comfort and safety, ease of use, and security. To enhance transit patronage, it is important to provide reliable transit information to the public, to enhance the reliability of transit services and to promote their ease of use.

Current technology supports the use of automatic vehicle location (AVL) navigational systems to track the location of transit vehicles and report deviations from transit schedules. One form of AVL is global positioning systems (GPS) which utilize a system of 16 earth orbiting satellites to determine a vehicle's location. A GPS-based system requires that a vehicle be equipped with a receiver/transmitter to transmit the vehicle's location to a central monitoring facility. Operators at the center can, therefore, take necessary actions to improve schedule adherence.

Another form of improving transit schedule reliability is to provide partial priority at signalized intersections. Partial priority can be offered to certain buses that are behind schedule, at certain non-critical intersections and/or at off peak periods. These parameters need close coordination between LVACTS and the bus operators.

Another means of improving bus operations is to promote ease of payment and transfers through "smart cards". There are many forms of smart cards, ranging from pre-paid cards to cards embedded with a chip to record passenger data and payment status. Use of smart cards will reduce boarding and transfer payment time and improve bus operations as well as providing a convenient service to patrons.

Las Vegas Valley Application:

The Regional Transportation Commission (RTC) has already approved plans to install GPS or other AVL equipment on buses. This program should tie with the regional traveler information system to allow sharing of information using buses as probes.

With AVL on buses, each bus's arrival time at the next bus stop can be calculated. Such information can be displayed at the bus stops by small size CMSs, similar to the type provided at some subway stations. This system can be further expanded to allow commuters to call a local number to request bus arrival time at any specific bus station. This will reduce the passenger waiting time at stations, reduce security anxieties and promote transit usage.

With AVL, the RTC operators can coordinate with LVACTS operators to request partial priorities for certain buses at certain intersections. This will require data and video communication between the bus operators and LVACTS operators.

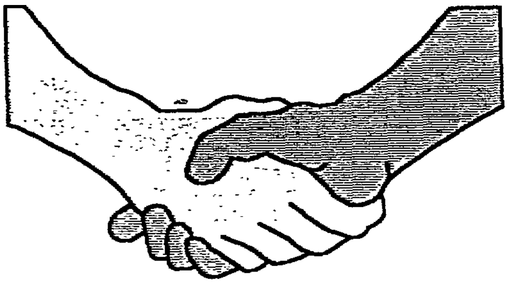
It is also recommended to develop use of smart cards in Las Vegas to promote ease of transit payment. These cards can also serve as multi-purpose cards for other payment purposes. It has been suggested that the casino slot machine player cards can be made as smart cards for transit payment, for example. Another suggestion was made to eliminate bus fares for all patrons with a smart card. This is intended to promote transit usage and allow registration of patrons.

Activities and Costs

The project activities and costs for the Transit Information System is summarized in Table 3.10.

TABLE 3.10: Project Activities and Costs
Program Area: 3.8 Transit Information System

		COSTS (IN $1000)			
		Transportation Related Capital	% Hwy	% Transit	Annual O&M
Project: **8.0**	**Transit Information System**				
8.0.1	Provide AVL for buses	3000	0	100	150
8.02	Upgrade transit operation system to provide individual bus schedules	2800	0	100	140
8.0.3	CMS at bus stops for bus arrival information	2000	0	100	100
8.0.4	Bus operations interface with LVACTS for video, voice and data transmission	50	0	100	0
8.0.5	Smart Cards	500	0	100	25
	Program Area Total	**8350**	**0**	**100**	**415**



CHAPTER 4
BENEFITS ASSESSMENT

4. BENEFITS ASSESSMENT

This chapter evaluates the benefits associated with the high priority programs discussed in Chapter 3.

One difficulty in determining the benefits of the program areas is that there is very little actual field data of ITS benefits in the Las Vegas Valley. Many of the ITS elements discussed in this report have not been implemented in the Las Vegas Valley. Therefore, empirical data based on experiences in other parts of the country are referenced. In this process, over 40 documents of ITS benefits were studied. These include field experiences in cities such as New York, Chicago, Seattle, Los Angeles, Minneapolis, and many others,

Through the empirical experiences of other cities, the ITS benefits are grouped under the following six high priority programs:

- Regional Traffic Management Center
- Freeway Management System
- Incident Management System
- Service Patrol on Freeways
- Cable TV Traveler Information System
- Transit Information System

Two of the eight high priority programs adopted by the RTC Board are omitted in the above list. They are “Automatic Incident Detection on Freeways” and “Accident Investigation Sites on Freeways”. Unlike the other projects, these two projects are not related to “system” improvements. Their deployment is tied to a larger “system” of incident management components. The benefits of deploying these two projects are therefore assessed as part of the overall incident management system.

Using previous research data, these benefits are converted into equivalent monetary values so that comparisons can be made directly against costs. This regional benefit/cost analyses of the six program areas are presented in Sections 4.1 to 4.6.

Nationally, congestion in 2005 will be five times that of 1984[5]. In large measure, this tremendous growth in congestion has been due to increased travel brought about by continued suburban development, increases in disposable incomes and increased labor

5 Mobility Facts. 1992.

participation rates as women increasingly move into the work force. Furthermore, the number of passengers per vehicle continues to decline. The sum of these developments has been that the number of vehicle miles of travel increased by 98.5% between 1969 and 1989 while the number of road mileage only increased by 4.5%.

The benefits of ITS projects are therefore best evaluated through their positive impact on the traveling public . These include:

- reduction of travel delay
- reduction of fuel consumption
- improvement of air quality
- reduction of accidents

The following sections discuss the quantification of the above benefits,

Travel Delay

The cost of delay is usually expressed as the cost of travel time. Travel delay experienced in the transportation network gives rise to loss of productivity in the workforce, individual driver frustration, delay of goods delivery, increased fleet size for transit, delay of emergency vehicles in life saving situations, and so on. A review of analyses performed in other metropolitan cities around the nation indicates that the compound effect of travel delay is quantified to be around $8 to $12 per hour. For the purpose of this study, the cost of travel time for Las Vegas Valley is assumed to be $10 per hour.

Fuel Consumption

Fuel savings is an indirect benefit resulting from the reduction of delay and stops. A major portion of fuel consumption can be attributed to stop-and-go situations. Frederick Wagner[6] gives an equation for the total fuel consumed expressed as a function of vehicle-miles-traveled and vehicle hours of travel. Although this equation was developed based upon less fuel efficient vehicles, it is nonetheless considered sufficient for this purpose of this analysis:

$$FTOT = 0.0425 * VMT + 0.6 * VHT$$

where: FTOT = total fuel consumed in gallons
VMT = vehicle miles traveled
VHT = vehicle hours of travel

6 Wagner, 1980.

Based on the RTC travel model data[7], the daily VMT and VHT for Las Vegas Valley are 18,530,500 vehicle-miles and 555,250 vehicle-hours respectively. Assuming the average fuel cost of $1.60 per gallon, the cost of total fuel consumption is estimated to be:

$$\begin{aligned} FTOT &= 0.0425 * 18{,}530{,}500 + 0.6 * 555{,}250 \\ &= 1{,}120{,}696 \text{ gallons daily} \\ &= \$\ 1{,}793{,}000 \text{ daily} \end{aligned}$$

Air Quality

Three major air pollutants arising from vehicular emissions are Carbon Monoxide (CO), Hydrocarbons (HC) and Nitrogen Oxide (NO,). The generation of these pollutants is determined in terms of pounds per 1000 vehicle hours (due to idling of vehicles) or pounds per 1000 vehicle miles of travel.

Table 4.1 shows the quantities of emissions for every 1000 vehicle hours of stopped delay (due to idling of vehicles). The table also indicates an equivalent dollar value accounting for the impact of each pound of chemical compound released into the atmosphere. These dollar values are very approximate and are based on property damage and health costs[8]. They were derived in 1977 and today's vehicles should be less polluting. Nonetheless, they are considered adequate for the current analysis.

TABLE 4.1: Emission Quantities from Stopped Vehicles

Compound	Quantity for 1000 veh-hours of stopped delay	Unit Cost per lb	Cost per 1000 veh-hours of delay
CO	2430 lbs	$0.026	$63.18
HC	160 Ibs	$0.40	$64.00
NO_X	50 lbs	$1.32	$66.00

For the Las Vegas Valley, assuming that 20% of total vehicle-hours of travel is stopped delay, the total stopped delay is estimated to be 111,000 vehicle-hours daily or 28.8 million vehicle-hour annually. (This should not be confused with the 12,475 vehicle-

7 RTC travel model data obtained from Dennis Mewshaw, May 1996.

8 Small, 1977.

hours of systemwide delay shown in page 12, because the systemwide delay is a parameter defined as delay caused by congestion. It does not include stopped delay at intersections, for example, that are not a direct result of traffic congestion. The total stopped delay used here for estimating air quality impacts include all causes of delay and stopped vehicles) The quantity of emissions is estimated as follows:

TABLE 4.2: Annual Cost Quantities for Emissions for the Las Vegas Valley

Compound	Total. Quantity of Emissions (lbs)	Total Cost for Each Compound
CO	69,984,OOO	$ 1,820,000
HC	4,608,OOO	$ 1,840,000
NO_X	1,440,000	$ 1,900.000

Accidents

In 1991, the State of California Department of Transportation (Caltrans) and the National Safety Council[9] conducted a survey on accidents to determine average costs for traffic related accidents. Accident costs broken down per accident type are as follows:

TABLE 4.3: Accident Costs

Accident Type	Cost/Accident
Fatality	$ 320,000
Injury Accident	$ 10,000
Property Damage Only	$ 3,000

9 Accident Facts, 1991.

A memo published by Caltrans identified that approximately 10% of injury accidents and 60% of property damage accidents are not reported. Costs shown above have been adjusted accordingly.

Based on accident statistics obtained from NDOT, METRO, NLVPD, HPD, the total number of accidents in Las Vegas Valley is presented in Table 4.4 below:

TABLE 4.4: Accident Summary for the Las Vegas Valley

	Injury Accidents	Non-Injury Accidents
Freeways:		
. I-15	851	1993
. US 95 North	225	525
. US 95 South	168	392
Total	**1,244**	**2,910**
City Streets:		
. METRO	7401	16,836
• Henderson	445	1,041
• North Las Vegas	660	1,541
Total	**8,506**	**18,028**

Benefit Analysis Methodology

Based on the empirical benefits derived in other cities, a benefit assessment analysis was performed for the Las Vegas Valley. This benefit assessment was performed in the six high priority programs of:

- Regional Traffic Management Center
- Freeway Management System
- Incident Management System
- Service Patrol on Freeways
- Cable TV Traveler Information System
- Transit Information System

Each of these projects will support a number of ITS services. The experience of these ITS services as derived in other cities were applied to the Las Vegas Valley travel characteristics. This provided an estimate of the potential benefits that could be derived in each of the program areas. However, the "maturity" of these ITS services would vary between the Las Vegas Valley and other cities, and the degree of benefits that could be realized depends on how "mature" the ITS deployment was. For example, a full deployment of all the ITS services within a program area may generate the maximum potential benefits. However, partial deployment of the ITS services up to, say, a 50% maturity, will only generate 50% of the benefits. The "degree of maturity" is therefore an estimate of how much of the potential benefits can be realized through deployment of a set of projects. Although this is a subjective judgment, it is intended to reflect the relative degree of benefits that can be derived in the Las Vegas Valley when the high priority programs discussed in Chapter 3 are deployed.

The following sections discuss this regional benefit/cost assessment for each of the six high priority programs.

4.1 Regional Traffic Management Center

A regional traffic management center (TMC) serves as the "brain" of the traffic management system. Around the country, many TMCs operate freeways or traffic signal systems and incorporate staff and facilities for some or all of the following: traffic signal control, freeway operations, toll collection, police, fire and rescue, transit and transportation planning. In most cases, different TMCs operating by different agencies locate in different venues. This gave rise to difficulty in coordination. The new trend is to combine these facilities into one location. Currently, TMCs that either combined or are planning to combine different systems with multiple agencies under one roof include the TransGuide Control Center in San Antonio, the State of Maryland CHART Operations Center, the Montgomery County Traffic Management Center, the Michigan Intelligent Transportation Systems Center in Detroit and the Houston TranStar Center. The Atlanta Advanced Traffic Management Center is operational for the 1996 Summer Olympics.

Few evaluations of integrated facilities are currently available; however, experiences from integrated centers and the trend in developing them tell a compelling story about the value of such facilities. The San Antonio TransGuide facility was opened in the summer of 1995. The value of an integrated facility was demonstrated the week before the center opened when an industrial plant fire erupted within view of freeway video monitoring. Based on the visibility afforded at TransGuide, the fire was accessed by firefighters continuously and was extinguished more effectively. Both local police and fire agencies were convinced of the wisdom of collocation.

Despite the intuitive benefits of a regional TMC that combines the function of traffic signal control, freeway management, incident management, and traveler information, no empirical information is available to quantify its benefits to the traveling public. Besides, since the TMC is an integral part of the operations of the overall freeway management, traffic signal control, incident management and traveler information systems, the benefits of the TMC are not separable from the benefits that are derived from the overall systems. Therefore, in this evaluation, the benefits of a regional TMC for the Las Vegas Valley are assessed through the benefits of the systems discussed in the following sections.

4.2 Freeway Management System

A freeway management system manages the movement of traffic accessing to and on the freeways. Through a combination of surveillance and control functions, it promotes maximum utilization of available capacity on the freeways.

Traditionally, freeway management systems utilize ramp metering to control the rate of traffic entering the freeway. detectors and CCTV cameras to provide surveillance of the facilities, and changeable message signs and highway advisory radio for conveying traveler information to the public.

A longitudinal study of the expressway management system including ramp metering in the Seattle, Washington, area over a six-year period[10] shows a growth in traffic of 10% to 100% along various segments of the I-5 while speeds have remained steady or increased by up to 48%. At the same time, accidents have fallen consistently to a current level of 62% compared to the base period. The improvements have occurred while average metering delays at each ramp have remained at or below 3 minutes.

The Minnesota DOT's Traffic Management Center, which operates expressways in the Minneapolis area, has produced the following experience[11] :

- Capacity is 2200 vplph compared to 1800 prior to the use of the ramp meters.
- Average speeds have risen from 34 mph to 46 mph.
- Accident rates on I-35W before were 421 per year and dropped to 308 Per year.
- Annual incident experience on I-35W after management is 2.11 collisions/MVM compared to 3.40 before management was instituted.

A survey of traffic management centers using ramp metering[12] reported similar findings. In addition to speed increases of 16% - 62% and throughput increases of 17% - 25% that were frequently used to justify the installations in a benefit/cost sense, accidents in expressway systems under expressway management were reduced between 15% and 50%.

The preliminary ramp metering analysis conducted for southbound I-95 on ramps in Stamford and Norwalk, Connecticut[13] showed that ramp metering will reduce demand on

10 Henry, K., and Meyhan, 0.6 Year FLOW Evaluation, Washington State DOT, District 1, January 1989.

11 Minnesota DOT Freeway Operations Meeting Minutes, January 1994.

I2 Robinson, J. and Piotrowicz G., Ramp Metering Status in North America, 1995 Update, Federal Highway Administration, June 1995.

13 Ramp Metering Engineering Feasibility Study, Stamford - Nonvalk, State Program No. 135-200, Dunn Engineering Associates, Revised September 1992.

upstream ramps and the mainline freeway. The design and construction costs of the metering system and associated recommended ramp modifications were estimated at $2,113,900. A benefit/cost ratio of 2.2: 1 was expected.

Efficient traffic management reduces congestion and improves safety. Reduction of congestion would also reduce the probability of secondary accidents. An Orange County TOS Study (OCTA) indicates that the implementation of a Traffic Operations Center (TOC) reduces the accident rate by 35%. A more conservative value based on urban systems suggests a 10% decrease (property damage only) in the accident rates for the city. Accordingly, reduction in fatality and injury accident rates can be assumed to be of the same order of magnitude.

Based on empirical studies of freeway management systems in other cities, the potential benefits of a freeway management system in Las Vegas Valley is presented in Table 4.5.

TABLE 4.5
Freeway Management Systems Potential Benefits

Travel Time	Decrease 8% - 48%
Travel Speed	Increase 16% - 62%
Vehicle Stops	Decrease 0% - 35%
Delay	Decrease 17% - 37%
Accident Reduction	Decrease 10% - 35%
Fuel Consumption	Decrease 6% - 12%
Emissions	Decrease 5% - 13% for CO emissions Decrease 4% - 10% for HC emissions

BENEFIT SAVINGS

The freeway management system in the Las Vegas Valley is expected to yield the following benefits:

- **Delay Savings**

Assuming that 20% of the daily vehicles-hour traveled in the Las Vegas Valley was on the fi-eeways, an 8% reduction in freeway travel time, based on 555,250 daily vehicle hours of travel, would equivalent to 8,884 vehicle hours saved. This would be equivalent to a cost of travel time savings of $89,000 daily, or annual savings of $22.2 million.

- **Fuel Savings**

As discussed earlier in this chapter, it was estimated that the Las Vegas Valley consumed approximately 1,120,000 gallons of fuel daily. Assuming that 20% of it was consumed on the freeway, a 6% decrease in fuel consumption on freeways would equal 13,440 gallons daily or 3.5 million gallons annually. This would represent an annual savings of $5.6 million.

- **Air Quality**

Again assuming that the freeway represents 20% of total emissions, a 5% decrease in CO emissions and 4% decrease in HC emissions would correspond to 7 million Ibs and 37,000 lbs annually, respectively. The combined monetary savings would be valued at approximately $200,000 annually.

- **Accident Reduction**

In 1994, the accident related costs on freeways for the Las Vegas Valley were estimated to be $17.9 million. A 10% decrease in accidents will result in savings of roughly $1.8 million a year.

The benefits and costs associated with the implementation of Freeway Management Systems are summarized in the following table:

TABLE 4.6
Benefit/Cost Assessment
Freeway Management Systems

Annual Potential Benefits for Matured Deployment	
• Delay Savings	22,200,000
• Fuel Savings	5,600,000
• Air Quality Savings	200,000
• Accident Savings	1,800,000
	$ 29,800,000
Assuming 80% maturity, i.e., 80% of potential benefits are realized, annual realizable benefits:	**$23,800,000**
Annual Cost	
Total Capital Cost	28,734,000
• Annual Cost (amortized over 10-year)	3,542,000
• AnnualO&M	1,309,000
	$4,850,000
Benefit/Cost Ratio	**4.9** : 1

4.3 Incident Management System

Aimed at quickly identifying incidents and implementing a response to minimize negative impacts on traffic, incident management programs have followed an evolutionary route to full deployment. Frequently, incident management programs have become part of the mission in expanding freeway management centers. Many of the existing incident management systems such as the Highway Helper Program in Minneapolis, the Incident Management component of the CHART program in Maryland and the Emergency Traffic Patrol in Illinois began as “eyes and ears” of motorists, incorporating technology such as cellular call-in, loop detectors, video monitoring and video detectors as technology and funding allowed. Incident management programs have demonstrated perceivable benefits in reducing incident clearance times, reducing the negative impact on traffic, and also reducing secondary incidents.

Among the metropolitan cities, about 50% - 60% of total traffic delay is attributable to incidents. The Institute of Transportation Engineers has estimated that the travel time would decrease by between 10% to 42% for incident management programs[14] The Maryland CHART program is in the process of expanding to more automated monitoring with lane sensors and video cameras. CHART funding comes from a variety of sources including the state budget process and application for federal programs such as Congestion Management/Air Quality funding and Interstate Discretionary funding[15]. This program is expected to have about a 10: 1 benefit/cost ratio[16] according to draft analyses, The Minnesota Highway Helper Program[17] reduces the duration of a stall (the most frequent type of incident, representing 84% of service calls) by 8 minutes. Using representative numbers, annual benefit through reduced delay totals $1.4 million for a program that costs $600,000 to operate. The reduction in secondary collisions attributable to the incident management program is difficult to estimate due to the coordinated freeway management program in the area.

TABLE 4.7: Incident Management Program Benefits

Incident Clearance Time	Decrease 8 minutes for stalls Decrease wrecker response time 5 - 7 minutes
Travel Time	Decrease 10% - 42%
Fatalities	Decrease 10% in urban areas

Using video monitoring can also aid the clearance of an incident. The City of Richardson, Texas, tied the operator of the city's towing concession into the roadway monitoring network with an investment of roughly $200. Using the information provided by the cameras, the tow truck dispatcher can position appropriate equipment near the collision site prior to the request for service from the police department. This advance

14 Meter. M. ed., A Toolbox for Alleviating Traffic Congestion, Institute of Transportation Engineers. Washington, DC. 1989.

I5 Points-du-Jour, J., Maryland State Highway Administration, telephone interview, November 1995.

16 Kuciemba, S., Maryland State Highway Administration, telephone interview, April 1995.

I7 Highway Helper Summary Report-Twin Cities Metro Area, Minnesota DOT, Report # TMC 07450-0394, July 1994.

notice reduces the response time for incident clearance by 5 - 7 minutes on average and greatly improves the ability to send equipment that will handle the active incident[18].

A study based on the Gardiner-Lake Shore Corridor identified that camera surveillance reduces incident detection time on average 5 - 7.5 minutes. This has significant impact during peak periods with high V/C ratios. Another study citation attributed delay savings of 10 vehicle-hours per incident to the video surveillance system.

A typical analysis was done by applying queuing theory techniques for an intersection with the following features:

V/C ratio between 0.8 - 0.9
Number of lanes in the approach: 4
Typical G/C ratio for the approach: 0.5
Number of lanes affected due to an incident: 1.4

Traffic conditions were simulated with and without the video surveillance. The presence of surveillance equipment is assumed to decrease the incident duration by about 6 minutes per incident. This information is summarized in the following table.

TABLE 4.8: Delay Savings Due to Video Surveillance

Incident Duration Without Video Surveillance	Incident Duration With Video Surveillance	Delay Savings per Incident Due to Video Surveillance
15 minutes	9 minutes	11 vehicle hours
25 minutes	19 minutes	20 vehicle hours

A study was conducted in the city of Santa Ana (CA) where accident statistics for the year 1991 indicated about 62 accidents occurred in the area of coverage of the surveillance cameras. Assuming that the actual lane blocking incidents are about 6 times more than the reported accidents, the total number of incidents would be about 372 per year. From the calculated delay range per incident, the delay savings for 372 incidents annually will be in the range of 37 vehicle hours.

In addition to delay reduction benefits, incident management programs are expected to benefit safety and emission reduction efforts. An analysis of the accident statistics on several California arterials and expressways shows that secondary accidents represent an

18 Edwards, M., Lewis Wrecker Service, telephone interview, December 1995.

increase in accident risks of over 600%[19] without controlling for climatic or other conditions. According to draft analysis based on data from the Fatal Accident Reporting System, reduction of incident notification times on urban freeways from the current average of 5.2 minutes to 3 minutes would result in a fatality reduction of 10% annually, or a national total of 212 lives if all freeways nationwide were under such a program[20] A reduction to 2 minutes would reduce fatalities by 308 annually. For comparison, the San Antonio TransGuide project has an incident detection goal of 2 minutes[21].

BENEFIT SAVINGS

Based on empirical analysis of other cities, implementation of an incident management system in Las Vegas Valley could give rise to the following benefits:

- **Delay Savings**

Non-recurrent delays would be reduced as a result of an incident management system, resulting in an estimated 10% reduction in travel time. This would translate to a savings of approximately 55,525 vehicle hours daily for the Las Vegas Valley, and is equivalent to a daily savings of $555,250 or $144.4 million annually. The calculations are as follows:

555,250 VHT (daily) * 0.10	= 55,525 veh-hours saved daily
55,525 veh-hours * $10.00	= $555,250 saved daily
$555,250 * 260 working days/year	= $144,365,000 saved annually

- **Fuel Savings**

The reduction in travel time further results in fuel savings. In 1995, the estimated daily vehicle miles traveled (VMT) is 18,530,500. The estimated daily vehicle hours traveled is 555,250. Assuming a mere 10% reduction in travel time, using the Wagner approach, the savings in fuel consumption alone is approximately $179,312 daily or $46.6 million a year. The calculations are as follows:

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19 Intelligent Transportation Systems Impact Assessment Framework: Final Report, Volpe National Transportation Systems Center, September 1995.

20 Evanco, W., "The Benefits of Rapid Incident Detection on Accident Fatalities," The MITRE Corporation, unpublished paper.

21 McGowan, P., and Irwin, P., "TransGuide Transportation Guidance System: Technology in Motion." Texas DOT, November 1995.

0.0425 * VMT + 0.6 * VHT = fuel consumption (in gallons)
0.0425 * 18,530,500 veh-mi. + 0.6 * 555,250 veh-hrs. = 1,120,696 gal/day
1,120,696 gal/day * 0.10 reduction = 112,070 gal/day
112,070 gal/day * $1.6 per gallon = $179,312 saved per day
$179,312 per day * 260 days/year = $46,621,120 saved annually

- **Accident Reduction**

Incident management systems have resulted in a decrease in fatalities of an average of 10%. Based on the accident data for the Las Vegas Valley, this would be equivalent to an annual savings of roughly $1,800,000. Additional savings would come from motorists being warned in advance of other accidents along their routes thereby preventing possible secondary accidents.

TABLE 4.9
Benefit/Cost Assessment
Incident Management System

Annual Potential Benefits for Matured Deployment	
• Delay Savings	144,400,000
• Fuel Savings	46,600,000
• Accident Savings	1,800,000
	192,800,000
Assuming 10% maturity, i.e., 10% of potential benefits are realized, annual realizable benefits:	**$19,300,000**
Annual Cost	
Total Capital Cost	4,260,000
• Annual Cost (amortized over 10-year)	525,000
• Annual O&M	115,000
	$640,000
Benefit/Cost Ratio	**30 to 1**

4.4 Service Patrols on Freeways

Service patrols reduce incident detection and clearance time. Roving vehicles on the freeway would detect disabled vehicles and accidents more quickly, and remove minor incidents expeditiously. The result would be a reduction in non-recurrent delay caused by incidents, improved safety by reducing secondary incidents, and improved fuel efficiency and reduced air pollutant emissions.

The Minnesota DOT freeway service patrol program reported that 89% of all incidents were detected by patrolling drivers, with the remaining being detected by the Traffic Management Center. The program was started in 1987 and covered approximately 65 centerline miles. Heavy duty pickups with a department staff of twelve (12) people provided 13 hours of coverage (equally divided between AM and PM). Each vehicle covered a route between 10 - 13 miles in length. In 1993, the program responded to 12,798 incidents (stalls 84%, accidents 6.4%, debris 5.4%, and others 4.2%.) The total program cost was $590,600. The benefit/cost ratio was 2.3: 1. The analysis showed that, on average. one minute of delay would cause five minutes of freeway traffic delay. Vehicle stalls, which accounted for 84% of all incidents attended, experienced a reduction of stall duration on average by 8 minutes.

The State of Colorado "Mile High Courtesy Patrol" operated 10 vehicles with each patrolling approximately 9 miles of freeways, 49 centerline miles for 5l/2 hours on weekdays. Through 6 months in 1995, the patrol responded to 5838 incidents (accidents 6%. abandoned vehicles 2 l%, remainder other types of service contacts) at a cost of $327,000 or $2,600 per day. An annual cost of approximately $700,000 has been budgeted or $5,447 per vehicle per month. A benefit analysis using $10 per vehicle per hour for the first six months was estimated between $4.3 M to $5 M, projecting a benefit/cost ratio of 15: 1. The Mile High Courtesy Patrol used private tow truck operators at a cost of $55/hr/truck. For comparison, the Los Angeles freeway service patrol program had an average bid cost of $42/hr. It was estimated that 70% of incidents were attended within 5 minutes. Prior to this service, the time of attendance was 25 minutes. An average of 85% of incidents were detected by the service patrols, the remaining 15 % by cellular contact. The service patrol averaged one assist/truck/hour.

Synthesizing the above information, implementing freeway service patrol in the Las Vegas Valley would potentially reduce the incident response time by 20 minutes for each incident. The other benefits of reducing secondary incidents could not be evaluated due to lack of empirical data.

According to accident statistics furnished by NDOT, there are on average 2150 accidents per year on the freeways in Las Vegas Valley. Using a time-displace diagram to estimate delay, assuming a generic arrival rate of 1000 vphpl, a reduction of incident response time of 20 minutes would result in a delay savings of 335 veh-hour per incident. This would be equivalent to an annual savings of 677,000 vehicle-hours, or $6.77 million per year of delay savings.

TABLE 4.10
Benefit/Cost Assessment
Freeway Service Patrols

Annual Potential Benefits for Matured Deployment	
• Delay Savings	6,770,000
Assuming 100% maturity, i.e., 100% of potential benefits are realized, realizable benefits:	$6,770,000
Annual Cost	
Total Capital Cost	80,000
• Annual Cost (amortized over lo-year)	10,000
• Annual O&M	550,000
	$560,000
Benefit/Cost Ratio	**12 to 1**

4.5 Cable TV Traveler Information System

Cable TV is a form of pre-trip traveler information system. It provides information for travelers before the start of a trip to select the best transportation mode, departure time and route. It allows travelers to access multimodal transportation information at home, work and hotel rooms where trips originate. Real-time information on transit routes, schedules, transfers. fares and ride matching services could encourage the use of transit. Real-time information on accidents, road construction, alternate routes, traffic speeds along given routes. parking conditions, event schedules and weather information could also be provided. Based on these information, the traveler can select the best route, modes of travel and departure time, or decide not to make the trip at all.

Several pre-trip traveler information projects have reported real benefits and increased popularity. The Los Angeles Smart Traveler project deployed 78 information kiosks in locations such as office lobbies and shopping plazas[22]. The number of daily accesses ranged from 20 to 100 in a 20-hour day, with the lowest volume in offices and the greatest in busy pedestrian areas. The most frequent request (83% of users) was for a expressway map. Over half of the users requested MTA bus and train information. Users. primarily upper middle class in the test area, were overwhelmingly positive in response to a survey.

An automated call-in transit information system implemented by the Rochester-Genesee Regional Transportation Authority resulted in an increase in calling volume by 80%[23], while a system installed by New Jersey Transit reduced caller wait time from an average of 85 seconds to 27 seconds and reduced caller hang-up rate from 10% to 3% while increasing the total number of callers[24] The Boston SmarTraveler has experienced 138% increase in usage from October 1994 to October 1995 to a total of 244,182 calls monthly, partly due to a partnership with a local cellular telephone service provider[25].

The Travlirik test in the Minneapolis area distributed PC and videotext terminals to 315 users and made available transit route and schedule information, including schedule adherence information as well as traffic incidents and construction information[26]. For the month of July, 1995, users logged on to the system a total of 1660 times, an average of

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22 Giuliano, G., Golob, J., and Hall, R., "Los Angeles Smart Traveler Information Kiosks," presented at the 74th Transportation Research Board Annual Meeting, January 1995.

23 USDOT, FTA, APTS Benefts. November 1995.

24 "NJ Transit's Customer Information Speeded Up by New System," Passenger Transport, January 24, 1994.

25 SmartRoute Systems Memorandum, "SmarTraveler Update," November 6, 1995.

26 Remer, M., Atherton, T., and Gardner, W., ITS Benefits, Evaluation and Costs: Results and Lessons from the Minnesota Guidestar Travlink Operational Tests, Draft, November, 1995.

slightly more than one access per participant per week. One third of the accesses to the system requested bus schedule adherence; another 3 1% examined bus schedules.
In addition, three downtown kiosks offering similar information averaged a total of 71 accesses per weekday between January and July of 1995 real-time traffic data were more frequently requested than bus schedule adherence.

Surveys performed in the Seattle, Washington and the Boston, Massachusetts areas indicate that 30% - 40%[27] of travelers frequently adjusted travel patterns based on travel information. Of those that changed travel patterns, about 45% changed route of travel and another 45% changed time of travel. An additional 5% - 10% changed travel mode.

Assuming that 30% of 96,000 daily callers changed travel plans according to this statistics, the impact of SmarTraveler in Boston on emissions has been estimated using the US EPA's MOBILE5a model. On a daily basis, this adjustment of travel behavior netted an estimated reduction of 1100 lbs of volatile organic compounds, 55 lbs of oxides of nitrogen, and 11070 lbs of carbon monoxide representing reductions of 25%, 1.5% and 33%, respectively of these pollutants from traveler changing travel plans. While only 28,800 daily trips are expected to be affected in a metropolitan area with 2.9 million registered drivers, this represented significant reductions for participating travelers.

Simulations performed using an urban scenario produced more encouraging indications of potential benefits[28]. For networks with congestion causing travel time to increase by a factor of three from free flow travel time but before saturation, equipped vehicles experienced a 8% - 20% advantage in travel time. As the network becomes saturated and before congestion significantly affected travel time the advantage of equipped vehicles was lower. For experienced commuters, the simulation predicted an aggregate travel time benefit of 7% - 12%. The relative benefit to longer trips was more significant than to shorter trips, which is consistent with a greater opportunity for advantageous diversion. The simulations were performed using a market penetration level of 5%. A separate simulation study predicted that pre-trip information on roadway conditions could result in a delay reduction of 15% when a capacity reducing incident occurred and off-road travel options were present[29].

Studies also indicated interest in traffic information on the part of the traveler as well as willingness to react to avoid congestion and delay. In focus groups for the Atlanta

27 Air Quality Benefit Study of the SmarTraveler Advanced Traveler Information Service, Tech Environmental, Inc.. July 1993.

28 Wunderlich, K., "Congestion and Route Guidance Benefits Assessment," The MITRE Corporation, letter ITS-L-131, October 1995.

29 Wunderlich, K., "Trip Planning, User Service Benefits Assessment," The MITRE Corporation, letter ITS-L-131, November 1995.

Advanced Traveler Information Kiosk Project[30], 92% - 98% of participants found the current information on accidents, alternate routes, road closures and traffic congestion to be useful and desirable. A survey in Marin County, California showed that if regular commuters had been presented with alternate routes including travel time estimates, 69% would have diverted and would have saved an average of 17 minutes[31], A pilot program in the Netherlands found a 40% increase in route diversions based on traffic information by the 300 vehicles equipped with FM sideband data receivers[32].

Based on the empirical data from the above studies, the potential benefits associated with the implementation of pre-trip traveler information in a matured environment are summarized in the following table.

TABLE 4.11
Pre-Trip Traveler Information Potential Benefits

Travel Time	Decrease 7% - 12%
Emissions	Decrease 33% of CO Decrease 1.5% of NO,

BENEFIT SAVINGS

By applying the above potential benefits to the Las Vegas Valley, implementation of cable TV pre-trip travel information service could result in the following potential savings:

- **Delay Savings**
  The average daily vehicle hours of travel in the Las Vegas Valley was 552,500 vehicle-hours. The 7% decrease in travel time is equivalent to 38,868 vehicle-hours saved daily. In monetary value, using $10.00 per vehicle-hour, the equivalent monetary value is approximately $389,000 daily or $101 million annually.

30 "Advanced Traveler Information Kiosk Project: Summary Report - Focus Groups," Catherine Ross and Associates, Inc., undated.

31 Khattak, A., Kanafani, A., and Le Colletter, E., "Stated and Reported Route Diversion Behavior: Implications on the Benefits of ATIS," University of California - Berkeley, UCB-ITS-PRR-94-13, 1994.

32 Broeders, W.P.B., "RDS/TMC as Traffic Management Tool and Commercial Products," Proceedings of the Second World Congress on Intelligent Transportation Systems, Yokohama Japan, November 1995.

- **Fuel Savings**

Using Wagner's formula, the 7% decrease in travel time would result in an annual fuel cost savings of approximately 78,400 gallons daily. This represents a monetary value of $125,400 daily or $32.6 million annually.

- **Emissions Savings**

The 33% reduction in CO and 1.5% reduction in NO, represent 23 million lbs and 21,600 lbs respectively. These emission reductions would result in savings in the amount of about $600,000 annually.

The results of the benefit and cost assessment for Cable TV traveler information system in Las Vegas is summarized in Table 4.12.

TABLE 4.12
Benefit/Cost Assessment
Cable TV Traveler Information Systems

Annual Potential Benefits for Matured Deployment	
• Delay Savings	$101,000,000
• Fuel Savings	32,600,000
• Air Quality Savings	600,000
	$134,200,000
Assuming 5% maturity, i.e., 5% of potential benefits are realized, annual realizable benefits:	**$6,710,000**
Annual Cost	
Total Capital Cost	$1,200,000
- Annual Cost (amortized over lo-year)	152,000
. Annual O&M	185,000
	$337,000
Benefit/Cost Ratio	**20 to 1**

4.6 Transit Information System

The transit information system provides real-time vehicle location to improve transit operations and provide real-time bus information to the public. Accurate information on bus location helps maintain transit schedules and assure transfer connections at inter-modal terminals.

For nearly a decade, transit properties and emergency vehicle operators have been installing and using vehicle location systems based on signpost, triangulation, LORAN and GPS technologies[33]. A recent study[34] found 24 US transit systems operating more than 10,000 vehicles under AVL supervision and another 31 in various stages of procurement. This represents a doubling of the number of deployed systems, with most new systems using a GPS-based location process. Five Canadian operators are using AVL on fleets totaling 3700 buses, including a 2300 vehicle fleet in Toronto. Coupled with computer-aided dispatching systems, vehicle location technologies are producing benefits in security, travel time, service reliability and cost effectiveness. Additionally, several operators have reported incidents where AVL information assisted in resolving their disputes with employees and patrons.

AVL/CAD provides precise position of the bus along its route and reports this to the central computer at the dispatch headquarters. This data is used to determine the on-time performance and provides the driver and the dispatcher with a visual indication of where the bus is (if desired) and schedule adherence (ahead of schedule or behind schedule). Some systems also provide run times on routes and a silent security alarm message capability. This can be used to provide real-time bus schedule information to the public to improve transit reliability.

Safety and security are major factors in decisions to install transit management systems. Situations benefiting from AVL and from communication systems installed as part of transit management systems include medical emergencies as well as threats and crimes involving passengers and those observed by bus drivers. Some agencies report response time of as little as 1 to 2 minutes while others report reductions of about 40%. Agencies have reported improved cooperation with police after being able to precisely locate a bus involved in an incident and having a transit dispatcher assist in apprehending criminals

33 Jones. W., ITS Technologies in Public Transit: Deployment and Benefits, USDOT ITS Joint Program Office November, 1995.

34 Casey, R., et.al., Advanced Public Transportation Systems: The State of the Art - Update '96, USDOT FTA, January 1996.

using bus location information. Bus operators also report an increased sense of security with silent alarm and vehicle location Capabilities[35].

TABLE 4.13: Transit Vehicle Management System Benefits

Travel Time	Decrease 15% - 18%
Service Reliability	Increase 12% - 23% in on-time performance
Security	Decrease incident response time to as little as one minute
Cost Effectiveness	45% annual return on investment

AVL and dispatching systems have most directly improved schedule adherence. Some agencies that have experienced these benefits are:

- The Mass Transit Administration in Baltimore reported a 23% improvement in on-time performance by AVL-equipped buses. The Baltimore MTA initially installed the system on 50 buses in 1991 and conducted a schedule performance test on buses with and without the equipment. They are now in the process of installing AVL on the remainder of their 8.50 buses.

- The Kansas City Area Transportation Authority improved on-time performance by 12% in the first year of operation using AVL, compared to a 7% improvement as the result of a coordinated effort between 1986 and 1989.

- Preliminary results from Milwaukee indicated a 28% decrease in the number of buses more than one minute behind schedules[36].

- Coordination between transit systems and traffic signal systems has also demonstrated operational benefits. Allowing buses to either extend green time or shorten red time by only a few seconds reduced bus travel time on a test route in Portland[37] by 5% to 8%.

An AVL system provides a rich source of data for analyzing bus operations. Examining AVL data collected in Kansas City led to a schedule revision that reduced the 200-vehicle

35 Jones, W., ITS Technologies in Public Transit: Deployment and Benefits, November 1995.

36 Jones, W., ITS Technologies in Public Transit: Deployment and Benefits, November 1995.

37 Kloos, W., et. al., Bus Priority at Traffic Signals in Portland, ITS Annual Meeting, March 1995.

fleet by 7 buses while reducing scheduled travel times by up to 10%. The Kansas City Area Transportation Authority reported an annual operating expense reduction of $0.5 million based on a $1.1 million investment.

Other transit systems have reported reductions in fleet size of 2% to 5% due to efficiencies of bus utilization[38]. Toronto, Canada has had an AVL system operating for several years and has resulted in a 4% reduction in the number of buses required to serve the existing routes.

Alternatively, the efficiency gains could be used to increase frequency by the same amount. Using AVL data for analysis purposes also reduces the need for staff to perform schedule adherence and travel time surveys. Estimates of savings range from $40,000 per survey to $1.5 million annually[39].

BENEFIT SAVINGS

The Las Vegas Valley has an extensive bus system that includes a fleet of over 170 buses which is owned and operated by Citizen's Area Transit (CAT). CAT services approximately 1.5 million passengers per month. The system provides service 7 days a week and currently runs 20 hours in the residential areas and 24 hours along the Strip and downtown. Besides fixed-route transit, CAT also provides on-demand transportation for those with disabilities. The CAT Paratransit service consists of 80 buses equipped to provide curb to curb transport. The benefits of a transit location and information system can be summarized as follows:

- **Delay Savings**

For the transit location and information project, travel time reduction translates into delay reduction experienced by the commuters. Assuming an average trip length for transit riders to be 30 minutes, a 15% reduction in commute time would result in delay savings equivalent to $9.75 million annually, as shown in the following calculations:

50,000 passengers/day * 260 days/yr * 0.5 hrs/trip = 6,500,000 hrs/year
6,500,000 hrs/year * 15 % reduction * $10/hr = $9.75 million/year

- **Equipment Savings**

38 Jones, W., ITS Technologies in Public Transit: Deployment and Benefits, November 1995

39 USDOT, FTA, APTS Benefits, November 1995.

Reduction in transit travel time translates into fleet reduction of the same magnitude. Hence a 15% reduction in fleet size would save the transit operators approximately $2.55 million in capital cost:

15% reduction * 170 buses * $100,000 per bus = $2.55 million

Amortized over 10 years, this savings in capital cost is equivalent to an approximate annual savings of $314,000. In addition, savings will come in the form of wages plus operations and maintenance costs that are discounted because of the smaller fleet size.

The benefits and costs associated with the implementation of public transit projects are summarized in the following table:

TABLE 4.14
Benefit/Cost Assessment
Transit Information Sytems

Annual Potential Benefits for Matured Deployment	
• Delay Savings	9,750,000
• Equipment Savings	314,000
	10,064,000
Assuming 50% maturity, i.e., 50% of potential benefits are realized, annual realizable benefits:	$5,032,000
Annual Cost	
Total Capital Cost	8,350,000
• Annual Cost (1 O-year)	1,029,000
• Annual O&M	415,000
	$1,444,000
Benefit/Cost Ratio	**3.5 to 1**

4.7 Summary of Benefit/Cost Analysis

To summarize the results of the previous sections, Table 4.15 summarizes the results of the benefit/cost analysis of the high priority programs for Las Vegas Valley:

TABLE 4.15
Summary of Benefit/Cost Analysis
for the High Priority Programs

High Priority Programs	Annual Benefits	Annual Costs	B/C Ratio
Freeway Management System	$23,800,000	$4,850,000	4.9 to 1
Incident Management System	$19,300,000	$640,000	30 to 1
Service Freeway Patrols	$6,770,000	$560,000	12 to 1
Cable TV Traveler Information System	$6,710,000	$340,000	20 to 1
Transit Information System	$5,030,000	$1,440,000	3.5 to 1
TOTAL	**$61,610,000**	**$7,830,000**	**7.9 to 1**

As shown in Table 4.15, implementation of the high priority programs discussed in Chapter 3 is expected to generate benefits annually that far exceed its costs.

CHAPTER 5
US 95 PILOT CORRIDOR

5. US 95 PILOT CORRIDOR

US Route 95 runs from the California stateline near Needles, California to north of Winnamucca, Nevada. It provides a primary northwest-southeast line haul movement through the Valley. Between Ann Road and the I-l5 Interchange, Route 95 runs in a north-south and east-west direction for approximately 9 miles. Being one of the busiest freeway segments in the Las Vegas Valley, this 9 mile stretch of the US-95 carries over 135,000+ vehicles per day, and peak period congestion is a recurring occurrence. It was estimated that over one-third of the Las Vegas Valley residents working in the resort corridor lives in the northwest quadrant served by this freeway. Because of this, US 95 Oren Greyson Expressway was chosen as the pilot corridor for the deployment of ITS. This segment of the US 95 along with the adjacent roadway network is shown in Figure 5-1.

The US 95 Pilot Corridor extends from north of Cheyenne Avenue to the I-15 Interchange (also known as the Spaghetti Bowl). Other interchanges are located at:

- Cheyenne Avenue
- Lake Mead Boulevard
- Summerlin Parkway/Rainbow Boulevard
- Jones Boulevard
- Decatur Boulevard
- Valley View Boulevard
- Rancho Drive
- Martin Luther King Boulevard

For the purposes of ITS deployment, the project area also included key arterials and a short segment of I-l5 parallel to US-95 that can serve as freeway alternates. These arterials include:

- Cheyenne Avenue
- Lake Mead Boulevard
- Washington Avenue
- Rainbow Boulevard
- Jones Boulevard
- Decatur Boulevard
- Rancho Drive
- Martin Luther King Boulevard

The project area intersections are shown in Figure 5-l and summarized in Table 5.1.

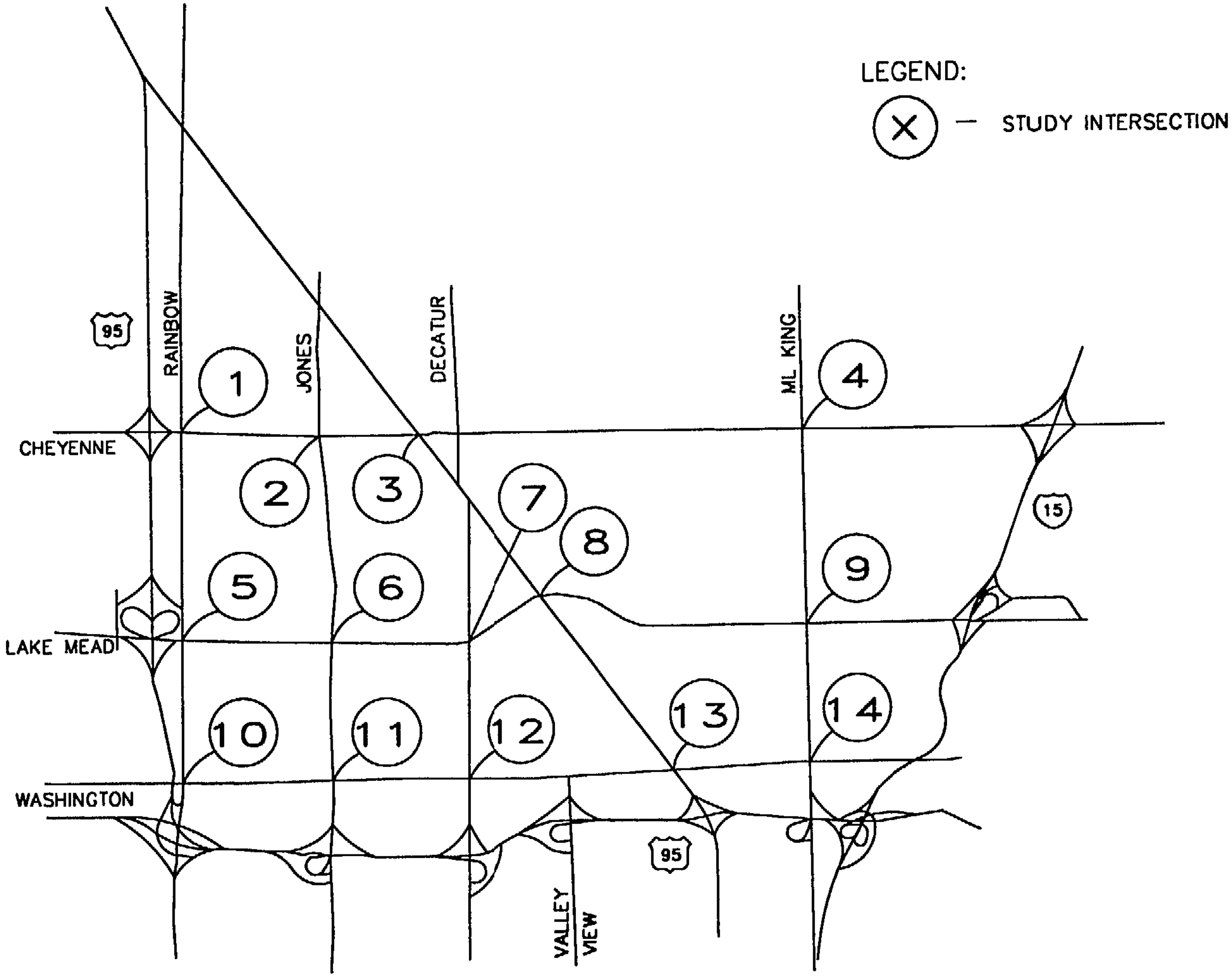


Figure 5-1
US-95 Study Intersections

TABLE 5.1: Project Area Intersections

1. Cheyenne Avenue at Rainbow Boulevard
2. Cheyenne Avenue at Jones Boulevard
3. Cheyenne Avenue at Rancho Drive
4. Cheyenne Avenue at Martin Luther King Boulevard
5. Lake Mead Boulevard at Rainbow Boulevard
6. Lake Mead Boulevard at Jones Boulevard
7. Lake Mead Boulevard at Decatur Boulevard
8. Lake Mead Boulevard at Rancho Drive
9. Lake Mead Boulevard at Martin Luther Ring Boulevard
10. Washington Avenue at Rainbow Boulevard
11. Washington Avenue at Jones Boulevard
12. Washington Avenue at Decatur Boulevard
13. Washington Avenue at Rancho Drive
14. Washington Avenue at Martin Luther King Boulevard

5.1 Operating Characteristics

The US 95 Pilot Corridor has two lanes in each travel direction between Cheyenne Avenue and the Summerlin Parkway. Between the Summerlin Parkway and the I-l5 interchange, US 95 has three lanes in each travel direction. All segments are proposed to be equipped with auxiliary lanes as part of the US-95 MIS efforts underway.

The US 95 Corridor experiences both recurrent and non-recurrent congestion as motorists commute daily to and from the downtown and the resort corridor. Recurrent congestion is a result of inadequate capacity along this facility. It is estimated that recurrent congestion resulted in approximately 1 million vehicle-hours of delay annually. This represented an annual cost of approximately $10 million.

Non-recurrent congestion occurred in the form of incidents. The US 95 Pilot Corridor experienced about 750 accidents per year, including 525 non-injury and 225 injury accidents. This accounted for approximately 600,000 vehicle-hours of delay annually, at an additional cost of $6 million..

5.1.1 Existing Traffic Conditions

For evaluating traffic conditions, performance at intersections is usually measured through level of service. Table 5.2 describes level of service for signalized intersections as presented in the Highway Capacity Manual.

TABLE 5.2: Level of Service Definitions for Signalized Intersections

Level of Service	Vehicle Delay (sec.)	Volume to Capacity Ratio	Description
A	≤ 5.00	0.00 - 0.59	Free Flow/Insignificant Delays: No approach phase is fully utilized by traffic and no vehicle waits longer than one red indication.
B	5.1 - 15.0	0.60 - 0.69	**Stable Operation/Minimal Delays:** An occasional approach phase is fully utilized. Many drivers begin to feel somewhat restricted within platoons of vehicles.
C	15.1 -25.0	0.70 - 0.79	**Stable Operation/Acceptable Delays:** Major approach phases fully utilized. Most drivers feel somewhat restricted.
D	25.1 - 40.0	*0.80* - 0.89	**Approaching Unstable/Tolerable Delays:** Drivers have to wait through more than one red signal indication. Queues may develop but dissipate rapidly, without excessive delays.
E	40.1- 60.0	0.90 - 0.99	**Unstable Operation/Significant Delays:** Volumes at or near capacity Vehicles may wait through several signal cycles. Long queues form upstream from intersection.
F	≥ 60.0	N/A	**Forced Flow/Excessive Delays:** Represents jammed conditions Intersection operates below capacity with low volumes. Queues may block upstream intersections.

Source: *Highway Capacity Manual,* Transportation Research Board, Special Report No. 209, Washington D.C., 1985; and Circular 212, Transportation Research Board, 1980.

Level of service (LOS) is used as a measure of effectiveness for the quality of traffic flow through an intersection. It is similar to a "report card" rating, based on average vehicle delay. Level of service A, B and C indicate conditions where vehicles can move freely. Level of service D and E are progressively worse. For signalized intersections, level of service F represents conditions where all vehicles through the intersection would generally experience long queues and delays.

Based on turning movement counts obtained for the US-95 MIS project, the level of service at the project area intersections were evaluated and presented in Tables 5.3 and 5.4. This are also shown in Figures 5-2 and 5-3.

TABLE 5.3: Level of Service Summary
Existing AM Peak

Intersection	V/C Ratio	Del/Veh (sec)	LOS
1. Cheyenne Avenue at Rainbow Boulevard	0.343	32.0	D
2. Cheyenne Avenue at Jones Boulevard	0.367	22.8	C
3. Cheyenne Avenue at Rancho Drive	0.589	24.3	C
4. Cheyenne Avenue at Martin Luther Ring Boulevard	0.773	24.5	C
5. Lake Mead Boulevard at Rainbow Boulevard	0.407	21.4	C
6. Lake Mead Boulevard at Jones Boulevard	0.635	24.7	C
7. Lake Mead Boulevard at Decatur Boulevard	0.635	23.8	C
8. Lake Mead Boulevard at Rancho Drive	0.778	24.8	C
9. Lake Mead Boulevard at Martin Luther King Boulevard	0.707	27.7	D
10. Washington Avenue at Rainbow Boulevard	0.674	22.3	C
11. Washington Avenue at Jones Boulevard	0.682	27.3	D
12. Washington Avenue at Decatur Boulevard	0.752	28.0	D
13. Washington Avenue at Rancho Drive	0.713	20.9	C
14. Washington Avenue at Martin Luther King Boulevard	0.606	17.2	C

Table 5.4: Level of Service Summary

Existing PM Peak

Intersection	V/C Ratio	Del/Veh (sec)	LOS
1. Cheyenne Avenue at Rainbow Boulevard	0.654	38.5	D
2. Cheyenne Avenue at Jones Boulevard	0.565	23.3	C
3. Cheyenne Avenue at Rancho Drive	0.746	31.8	D
4. Cheyenne Avenue at Martin Luther King Boulevard	0.732	24.9	C
5. Lake Mead Boulevard at Rainbow Boulevard	0.581	25.0	C
6. Lake Mead Boulevard at Jones Boulevard	0.769	27.2	D
7. Lake Mead Boulevard at Decatur Drive	0.730	31.0	D
8. Lake Mead Boulevard at Rancho Drive	0.841	32.6	D
9. Lake Mead Boulevard at Martin Luther King Boulevard	0.895	30.9	D
10. Washington Avenue at Rainbow Boulevard	0.741	20.6	C
11. Washington Avenue at Jones Boulevard	0.852	27.8	D
12. Washington Avenue at Decatur Drive	0.845	31.9	D
13. Washington Avenue at Rancho Drive	0.828	32.7	D
14. Washington Avenue at Martin Luther King Boulevard	0.805	23.3	C

Review of Tables 5.3 and 5.4 indicates that all of the intersections are operating at levels of service D or better. This indicates that in 1996, the project area intersections are generally operating satisfactorily in both the morning and evening peak conditions. One important conclusion to be drawn here is that, despite the congested conditions on the freeway, the parallel arterials are operating with spare capacity. One way of relieving congestion on US-95 would be to balance its demand with that of the parallel arterials.

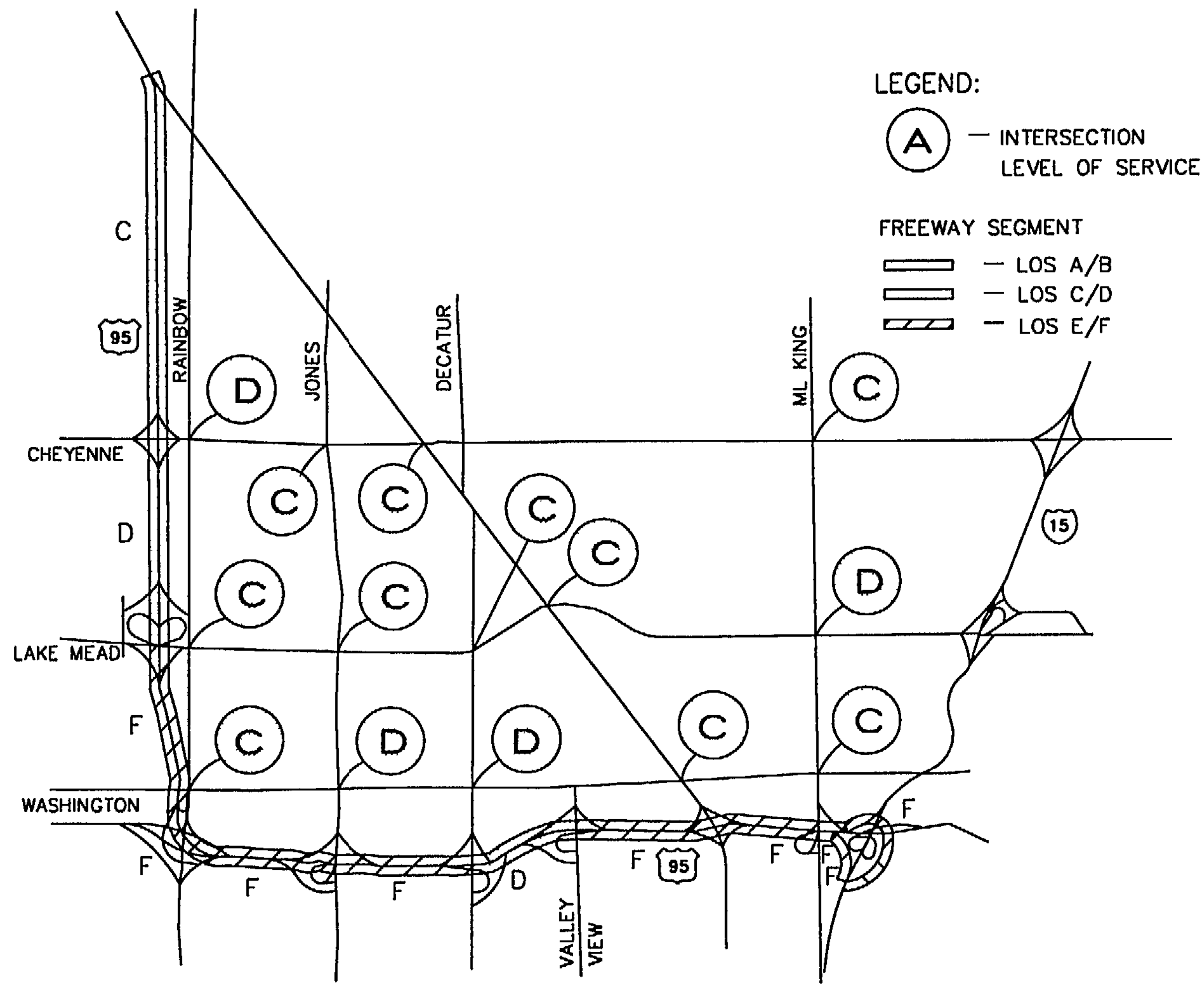


Figure 5-2
Level of Service - 1996 AM Peak

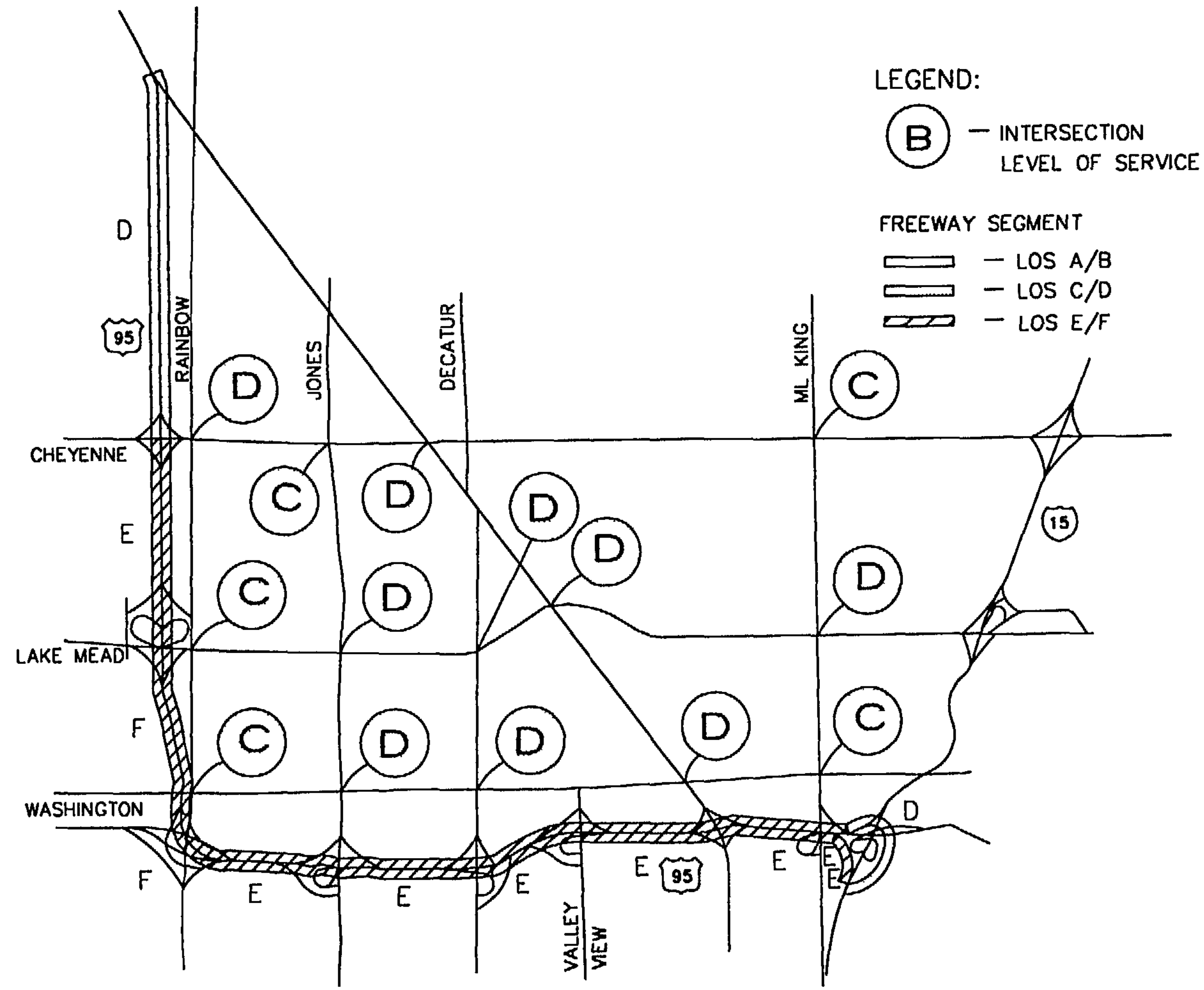


Figure 5-3
Level of Service - 1996 PM Peak

5.2 Freeway Management System

Given the objective of balancing the traffic demand on US-95 and its parallel arterials, one means is to implement a freeway management system. The primary objectives of the freeway management system are:

- Observe traffic conditions
- Control traffic
- Provide traveler information
- Promote incident management
- Balance "corridor" traffic demand

A freeway management system could facilitate the diversion of traffic away from US 95 to the parallel arterials by controlling traffic and providing route guidance information to the public. In order to ascertain the degree in which the parallel arterials can accommodate the increasing traffic demand, six different scenarios were analyzed to determine the level of service at the parallel arterials with increasing diversion from the freeway. The first five scenarios assume a "theoretical" number of vehicles diverted from the freeway. They are:

- Diversion of 200 vehicles
- Diversion of 400 vehicles
- Diversion of 600 vehicles
- Diversion of 800 vehicles
- Diversion of 1000 vehicles

It should be noted that the LOS at some intersections with additional traffic has improved from the existing condition. It is because the signal timings were optimized in each analysis. This illustrates the importance of optimizing traffic signal timings towards improving the level of service.

From the results of these five scenarios, a "balanced diversion" scenario was developed. This represents the scenario where a suitable amount of traffic was diverted at each freeway on-ramp to the parallel corridors without causing either the freeway or the parallel arterials to be overloaded. This represents the situation when the capacity of the freeway and arterial corridors are optimally used. Under this condition, even though the diverted motorists would take 5 to 10 minutes longer than the freeway users, they would still experience a shorter travel time than if they had stayed on the congested freeway. The freeway speed would be close to free flow, and the overall travel time of the network would be improved significantly, resulting in benefits for both the freeway and diverted traffic.

The results of the analyses are summarized in Tables 5.5 through 5.14. These are also presented in Figures 5-4 through 5-8 Figures 5-9 and 5-10 show the "balanced diversion" levels of service for the AM and PM peak periods.

Table 5.5: Level of Service Summary

200 Vehicles Diverted - AM Peak

Intersection	V/C Ratio	Del/Veh (sec)	LOS
1. Cheyenne Avenue at Rainbow Boulevard	0.654	21.3	B
2. Cheyenne Avenue at Jones Boulevard	0.421	13.5	A
3. Cheyenne Avenue at Rancho Drive	0.528	15.1	A
4. Cheyenne Avenue at Martin Luther King Boulevard	0.562	15.2	A
5. Lake Mead Boulevard at Rainbow Boulevard	0.526	17.1	A
6. Lake Mead Boulevard at Jones Boulevard	0.605	16.4	B
7. Lake Mead Boulevard at Decatur Drive	0.650	15.4	B
8. Lake Mead Boulevard at Rancho Drive	0.554	15.3	A
9. Lake Mead Boulevard at Martin Luther King Boulevard	0.540	15.7	A
10. Washington Avenue at Rainbow Boulevard	0.832	24.3	D
11. Washington Avenue at Jones Boulevard	0.59	16.0	A
12. Washington Avenue at Decatur Drive	0.786	19.3	C
13. Washington Avenue at Rancho Drive	0.754	14.8	C
14. Washington Avenue at Martin Luther King Boulevard	0.552	11.9	A

TABLE 5.6: Level of Service Summary
200 Vehicles Diverted - PM Peak

Intersection	V/C Ratio	Del/Veh(sec)	LOS
1. Cheyenne Avenue at Rainbow Boulevard	0.368	17.3	A
2. Cheyenne Avenue at Jones Boulevard	0.512	16.5	A
3. Cheyenne Avenue at Rancho Drive	0.639	18.0	B
4. Cheyenne Avenue at Martin Luther King Boulevard	0.675	18.0	B
5. Lake Mead Boulevard at Rainbow Boulevard	0.582	16.8	A
6. Lake Mead Boulevard at Jones Boulevard	0.655	19.0	B
7. Lake Mead Boulevard at Decatur Boulevard	0.650	17.6	B
8. Lake Mead Boulevard at Rancho Drive	0.614	18.0	B
9. Lake Mead Boulevard at Martin Luther King Boulevard	0.512	15.2	A
10. Washington Avenue at Rainbow Boulevard	0.619	17.0	B
11. Washington Avenue at Jones Boulevard	0.654	17.0	B
12. Washington Avenue at Decatur Boulevard	0.845	21.0	D
13. Washington Avenue at Rancho Drive	0.738	15.0	C
14. Washington Avenue at Martin Luther King Boulevard	0.638	16.4	B

Table 5.7: Level of Service Summary

400 Vehicles Diverted - AM Peak

Intersection	V/C Ratio	Del/Veh (sec)	LOS
1. Cheyenne Avenue at Rainbow Boulevard	0.689	21.0	B
2. Cheyenne Avenue at Jones Boulevard	0.476	12.7	A
3. Cheyenne Avenue at Rancho Drive	0.566	15.2	A
4. Cheyenne Avenue at Martin Luther King Boulevard	0.617	15.1	B
5. Lake Mead Boulevard at Rainbow Boulevard	0.511	16.44	A
6. Lake Mead Boulevard at Jones Boulevard	0.611	16.5	B
7. Lake Mead Boulevard at Decatur Drive	0.704	16.3	C
8. Lake Mead Boulevard at Rancho Drive	0.594	15.9	A
9. Lake Mead Boulevard at Martin Luther King Boulevard	0.578	16.1	A
10. Washington Avenue at Rainbow Boulevard	0.953	35.0	E
11. Washington Avenue at Jones Boulevard	0.646	16.8	B
12. Washington Avenue at Decatur Drive	0.840	21.0	D
13. Washington Avenue at Rancho Drive	0.811	16.8	D
14. Washington Avenue at Martin Luther King Boulevard	0.608	13.4	B

Table 5.8: Level of Service Summary

400 Vehicles Diverted - PM Peak

Intersection	V/C Ratio	Del/Veh (sec)	LOS
1. Cheyenne Avenue at Rainbow Boulevard	0.407	16.5	A
2. Cheyenne Avenue at Jones Boulevard	0.551	16.1	A
3. Cheyenne Avenue at Rancho Drive	0.676	18.1	B
4. Cheyenne Avenue at Martin Luther King Boulevard	0.731	18.1	C
5. Lake Mead Boulevard at Rainbow Boulevard	0.638	16.6	B
6. Lake Mead Boulevard at Jones Boulevard	0.679	19.1	B
7. Lake Mead Boulevard at Decatur Drive	0.681	18.0	B
8. Lake Mead Boulevard at Rancho Drive	0.653	18.5	B
9. Lake Mead Boulevard at Martin Luther King Boulevard	0.512	15.5	A
10. Washington Avenue at Rainbow Boulevard	0.685	17.9	B
11. Washington Avenue at Jones Boulevard	0.670	17.7	B
12. Washington Avenue at Decatur Drive	0.899	23.5	D
13. Washington Avenue at Rancho Drive	0.792	16.6	C
14. Washington Avenue at Martin Luther King Boulevard	0.694	17.6	B

TABLE 5.9: Level of Service Summary
600 Vehicles Diverted - AM Peak

Intersection	V/C Ratio	Del/Veh(sec)	LOS
1. Cheyenne Avenue at Rainbow Boulevard	0.727	20.9	C
2. Cheyenne Avenue at Jones Boulevard	0.531	12.0	A
3. Cheyenne Avenue at Rancho Drive	0.606	15.2	B
4. Cheyenne Avenue at Martin Luther King Boulevard	0.673	15.1	B
5. Lake Mead Boulevard at Rainbow Boulevard	0.567	15.8	A
6. Lake Mead Boulevard at Jones Boulevard	0.718	16.8	C
7. Lake Mead Boulevard at Decatur Boulevard	0.758	17.2	C
8. Lake Mead Boulevard at Rancho Drive	0.631	16.3	B
9. Lake Mead Boulevard at Martin Luther King Boulevard	0.617	16.4	B
10. Washington Avenue at Rainbow Boulevard	1.096	68.7	F
11. Washington Avenue at Jones Boulevard	0.703	17.5	C
12. Washington Avenue at Decatur Boulevard	0.896	23.5	D
13. Washington Avenue at Rancho Drive	0.865	18.9	D
14. Washington Avenue at Martin Luther King Boulevard	0.662	14.6	B

Table 5.10: Level of Service Summary

600 Vehicles Diverted - PM Peak

Intersection	V/C Ratio	Del/Veh (sec)	LOS
1. Cheyenne Avenue at Rainbow Boulevard	0.446	15.7	A
2. Cheyenne Avenue at Jones Boulevard	0.590	15.7	A
3. Cheyenne Avenue at Rancho Drive	0.715	18.3	C
4. Cheyenne Avenue at Martin Luther King Boulevard	0.786	18.6	C
5. Lake Mead Boulevard at Rainbow Boulevard	0.693	16.5	B
6. Lake Mead Boulevard at Jones Boulevard	0.175	19.1	C
7. Lake Mead Boulevard at Decatur Drive	0.718	18.3	C
8. Lake Mead Boulevard at Rancho Drive	0.692	18.9	B
9. Lake Mead Boulevard at Martin Luther King Boulevard	0.528	15.7	A
10. Washington Avenue at Rainbow Boulevard	0.781	65.5	C
11. Washington Avenue at Jones Boulevard	0.727	18.7	C
12. Washington Avenue at Decatur Drive	0.956	27.8	E
13. Washington Avenue at Rancho Drive	0.846	18.5	D
14. Washington Avenue at Martin Luther King Boulevard	0.750	18.8	C

TABLE 5.11: Level of Service Summary
800 Vehicles Diverted - AM Peak

Intersection	V/C Ratio	Del/Veh (sec)	LOS
1. Cheyenne Avenue at Rainbow Boulevard	0.766	20.9	C
2 Cheyenne Avenue at Jones Boulevard	0.586	11.6	A
3. Cheyenne Avenue at Rancho Drive	0.645	15.2	B
4. Cheyenne Avenue at Martin Luther King Boulevard	0.728	15.3	C
5. Lake Mead Boulevard at Rainbow Boulevard	0.622	15.4	B
6. Lake Mead Boulevard at Jones Boulevard	0.769	17.2	C
7. Lake Mead Boulevard at Decatur Boulevard	0.814	18.4	D
8. Lake Mead Boulevard at Rancho Drive	0.671	16.7	B
9. Lake Mead Boulevard at Martin Luther King Boulevard	0.654	16.6	B
10. Washington Avenue at Rainbow Boulevard	1.218	122.1	F
11. Washington Avenue at Jones Boulevard	0.756	18.3	C
12. Washington Avenue at Decatur Boulevard	0.953	27.8	E
13. Washington Avenue at Rancho Drive	0.921	22.2	E
14. Washington Avenue at Martin Luther King Boulevard	0.718	15.8	C

TABLE 5.12: Level of Service Summary
800 Vehicles Diverted - PM Peak

Intersection	V/C Ratio	Del/Veh (sec)	LOS
1. Cheyenne Avenue at Rainbow Boulevard	0.485	15.0	A
2. Cheyenne Avenue at Jones Boulevard	0.625	15.4	B
3. Cheyenne Avenue at Rancho Drive	0.754	18.5	C
4. Cheyenne Avenue at Martin Luther King Boulevard	0.841	20.0	D
5. Lake Mead Boulevard at Rainbow Boulevard	0.748	16.8	C
6. Lake Mead Boulevard at Jones Boulevard	0.754	19.3	C
7. Lake Mead Boulevard at Decatur Boulevard	0.757	18.7	C
8. Lake Mead Boulevard at Rancho Drive	0.728	19.3	C
9. Lake Mead Boulevard at Martin Luther King Boulevard	0.567	15.8	A
10. Washington Avenue at Rainbow Boulevard	0.856	130.1	D
11. Washington Avenue at Jones Boulevard	0.780	19.8	C
12. Washington Avenue at Decatur Boulevard	1.012	35.8	F
13. Washington Avenue at Rancho Drive	0.902	21.1	E
14. Washington Avenue at Martin Luther King Boulevard	0.805	20.2	D

TABLE 5.13: Level of Service Summary
1000 Vehicles Diverted - AM Peak

Intersection	V/C Ratio	Del/Veh (sec)	LOS
1. Cheyenne Avenue at Rainbow Boulevard	0.804	21.1	D
2. Cheyenne Avenue at Jones Boulevard	0.642	11.3	B
3. Cheyenne Avenue at Rancho Drive	0.682	15.2	B
4. Cheyenne Avenue at Martin Luther King Boulevard	0.783	15.7	C
5. Lake Mead Boulevard at Rainbow Boulevard	0.677	15.1	B
6. Lake Mead Boulevard at Jones Boulevard	0.825	18.1	D
7. Lake Mead Boulevard at Decatur Boulevard	0.870	20.2	D
8. Lake Mead Boulevard at Rancho Drive	0.710	17.1	C
9. Lake Mead Boulevard at Martin Luther King Boulevard	0.694	16.8	B
10. Washington Avenue at Rainbow Boulevard	1.357	214.4	F
11. Washington Avenue at Jones Boulevard	0.813	19.3	D
12. Washington Avenue at Decatur Boulevard	1.004	35.0	F
13. Washington Avenue at Rancho Drive	0.978	28.0	E
14. Washington Avenue at Martin Luther King Boulevard	0.771	16.9	C

TABLE 5.14: Level of Service Summary
1000 Vehicles Diverted - PM Peak

Intersection	V/C Ratio	Del/veh (sec)	LOS
1. Cheyenne Avenue at Rainbow Boulevard	0.524	14.4	A
2. Cheyenne Avenue at Jones Boulevard	0.664	15.2	B
3. Cheyenne Avenue at Rancho Drive	0.793	18.9	C
4. Cheyenne Avenue at Martin Luther King Boulevard	0.896	21.4	D
5. Lake Mead Boulevard at Rainbow Boulevard	0.803	17.3	D
6. Lake Mead Boulevard at Jones Boulevard	0.792	199.6	C
7. Lake Mead Boulevard at Decatur Boulevard	0.796	19.2	C
8. Lake Mead Boulevard at Rancho Drive	0.767	19.8	C
9. Lake Mead Boulevard at Martin Luther King Boulevard	0.603	15.8	B
10. Washington Avenue at Rainbow Boulevard	1.414	168.6	F
11. Washington Avenue at Jones Boulevard	0.836	21.3	D
12. Washington Avenue at Decatur Boulevard	1.064	47..6	F
13. Washington Avenue at Rancho Drive	0.958	25.2	E
14. Washington Avenue at Martin Luther King Boulevard	0.861	21.9	D

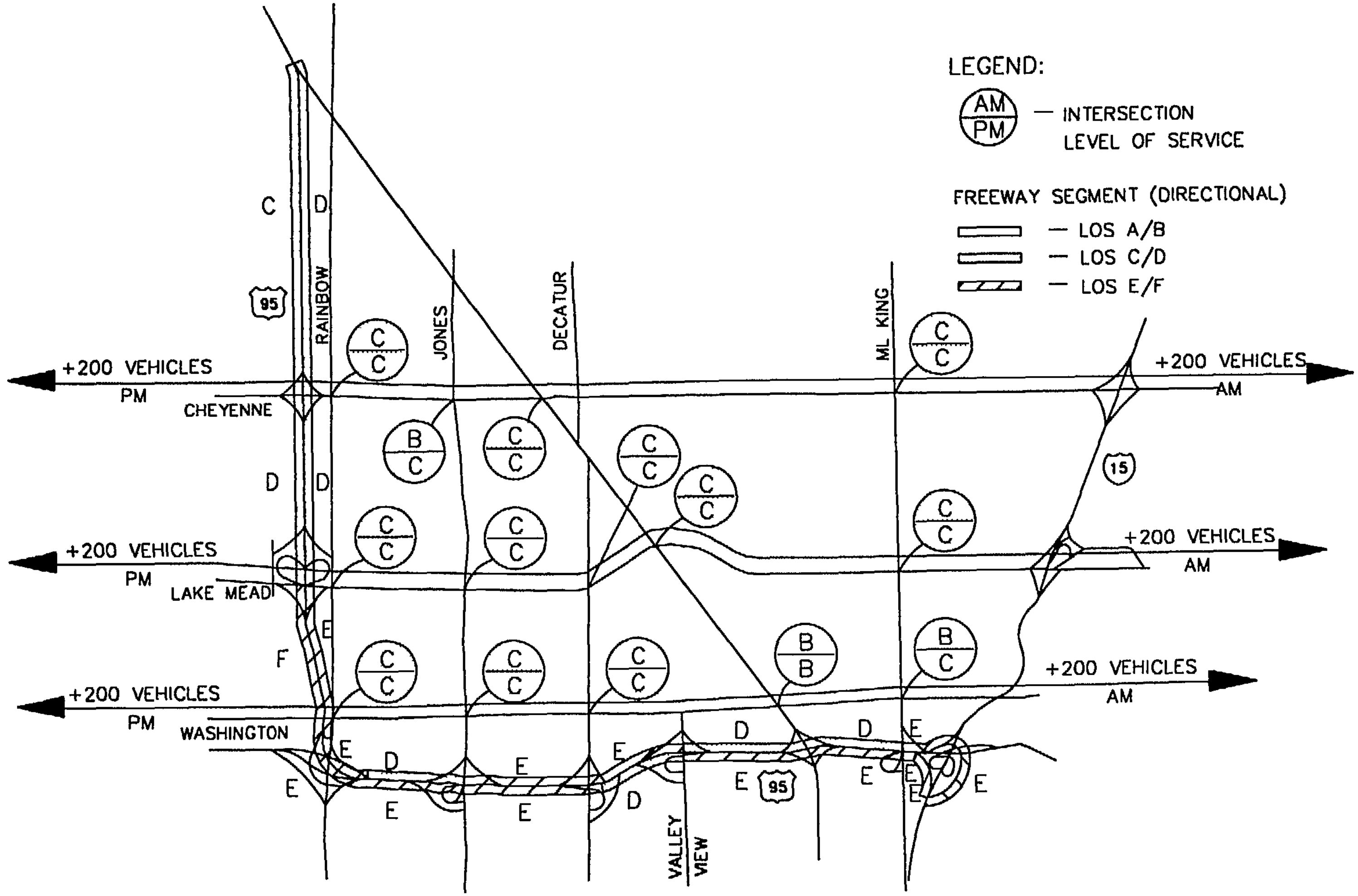


Figure 5-4
200 Vehicles Diverted

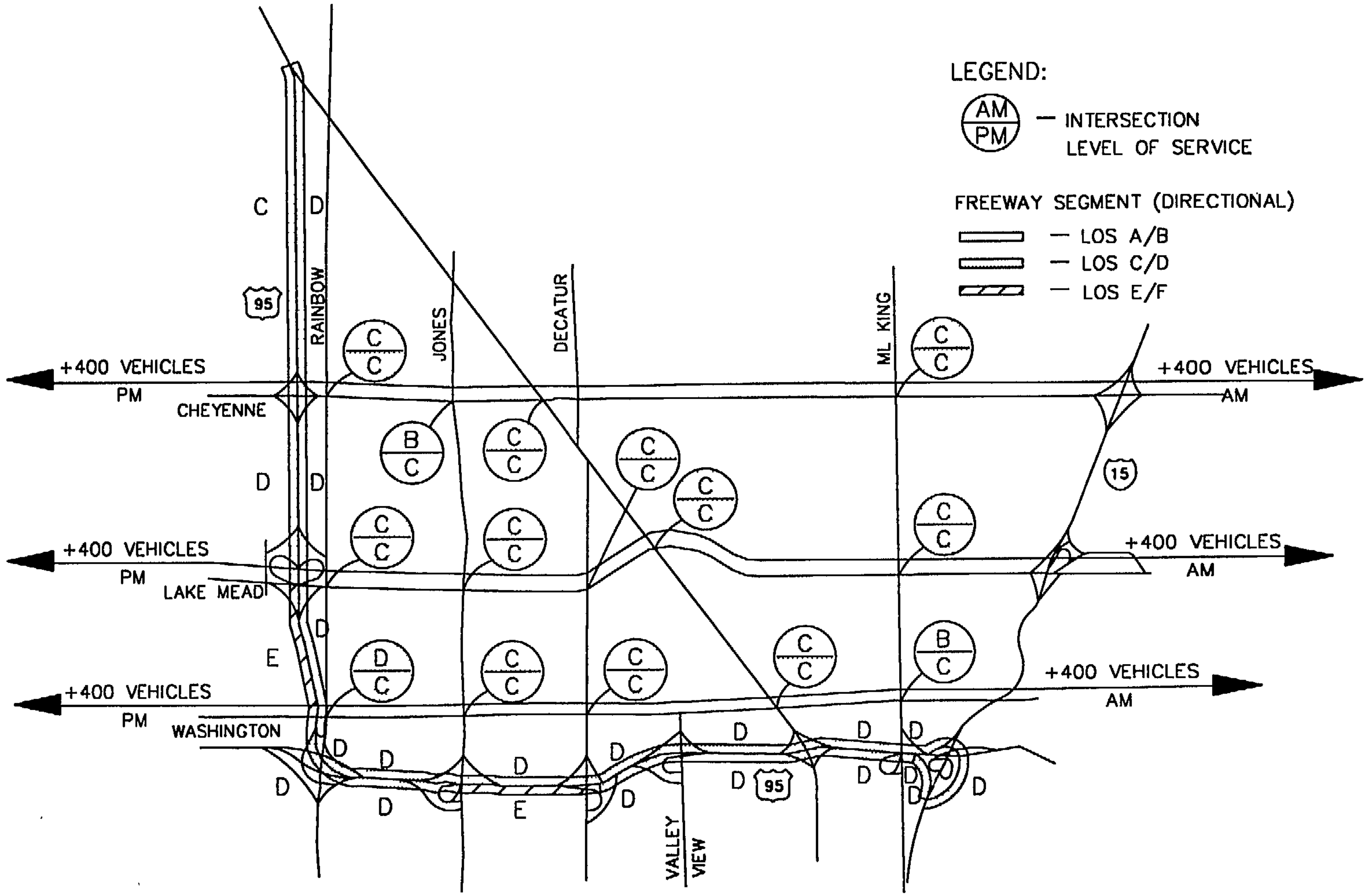


Figure 5-5
400 Vehicles Diverted

DKS Associates

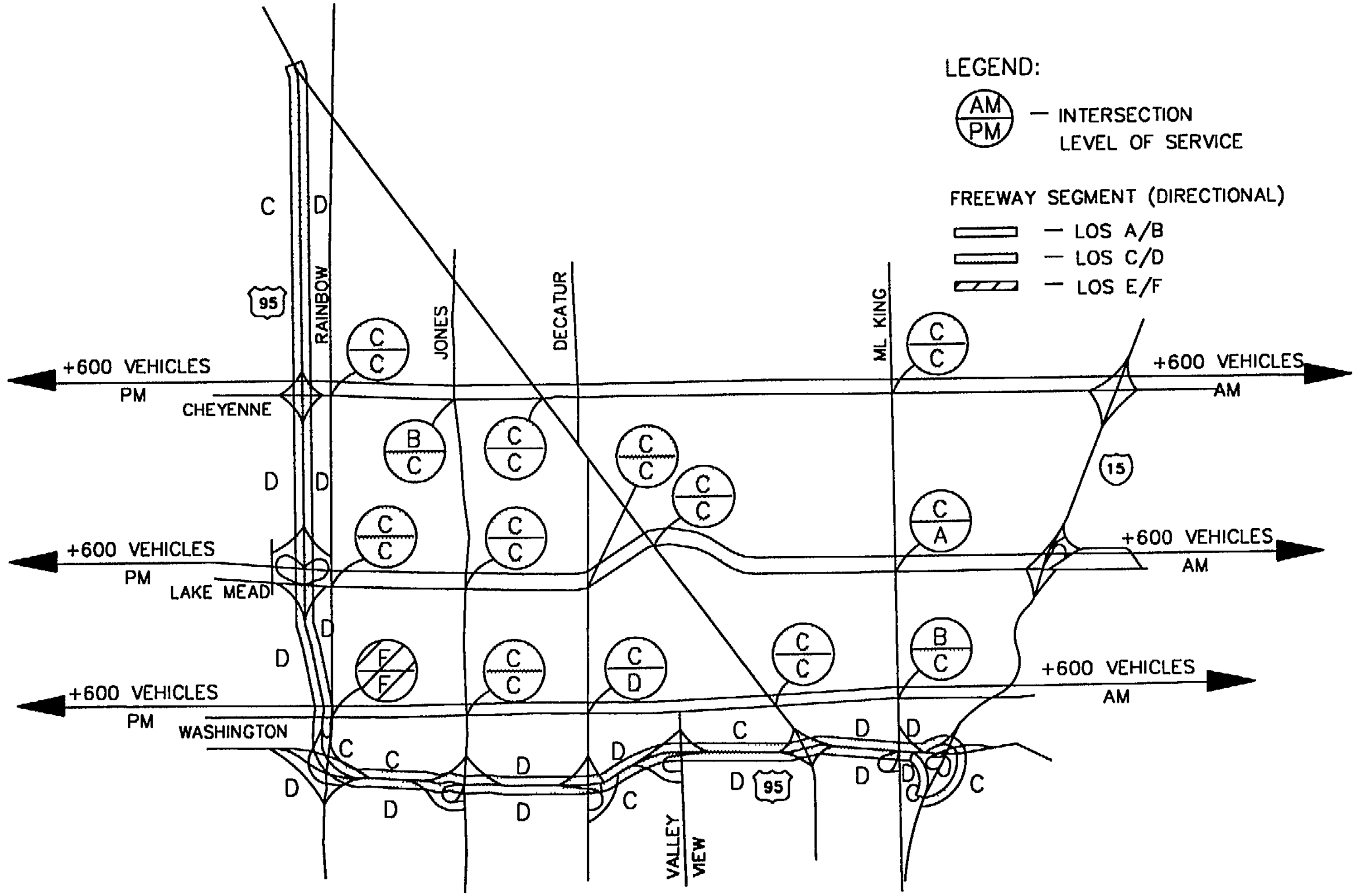


Figure 5-6
600 Vehicles Diverted

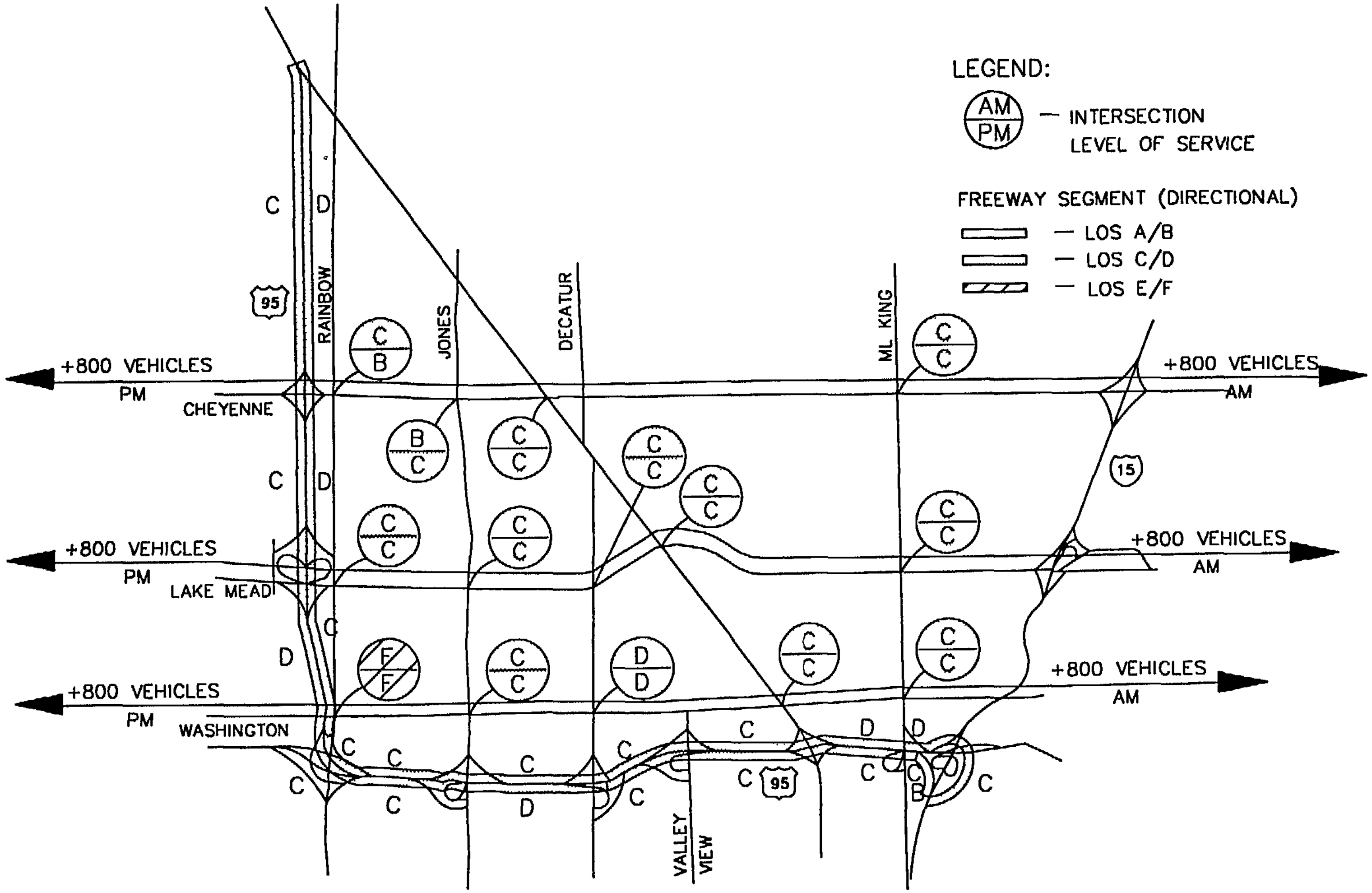


Figure 5-7
800 Vehicles diverted

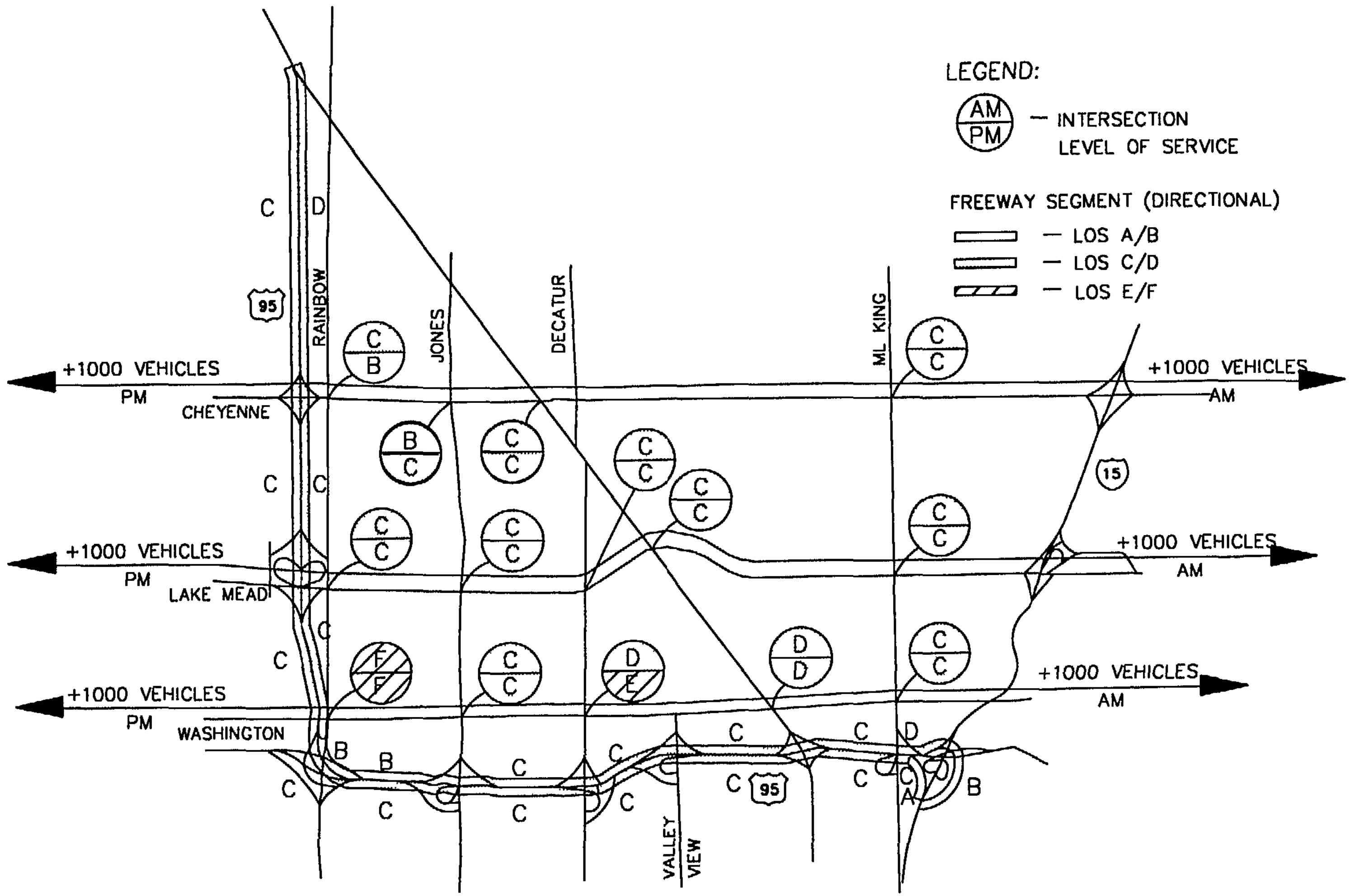


Figure 5-8
1000 Vehicles Diverted

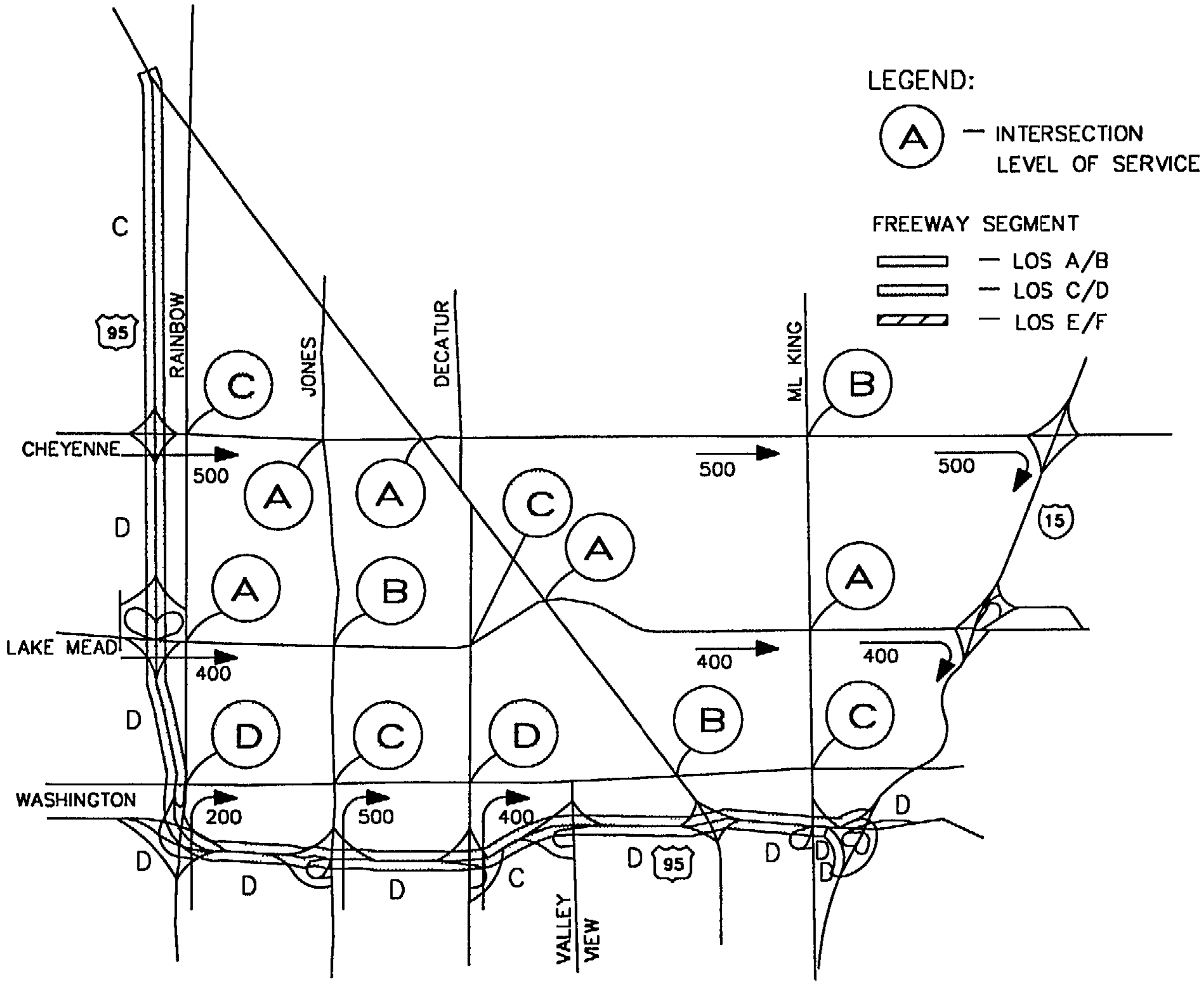


Figure 5-9
Balanced Capacity with ITS
AM Peak

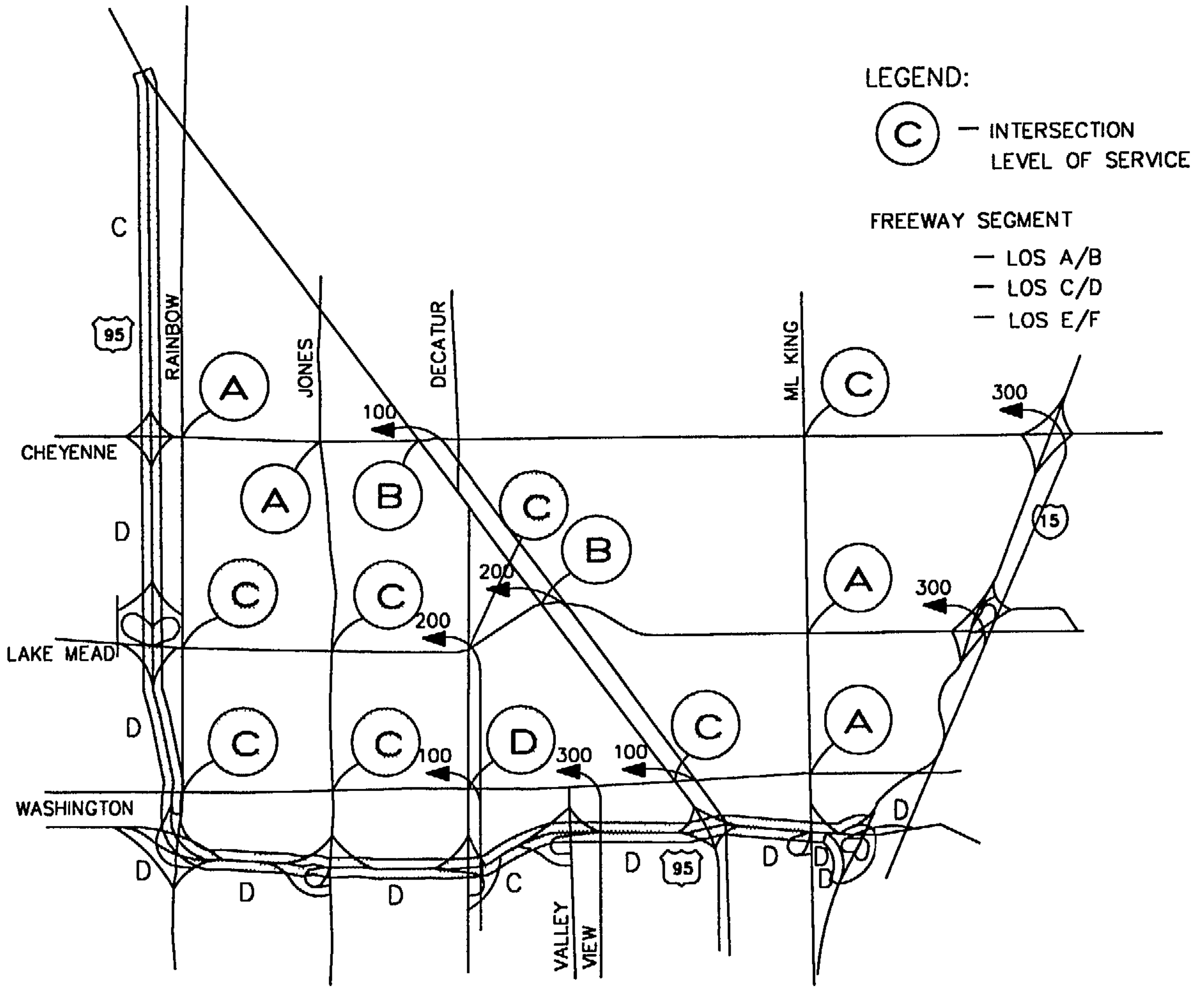


Figure 5-10
Balanced Capacity with ITS
PM Peak

5.2.1 Required Infrastructure

The establishment of a "balanced diversion" scenario confirmed the ability of the roadway infrastructure to handle the existing demand when their utilization is optimized. A freeway management system could provide traffic control and traveler information under varying traffic conditions to promote suitable diversion of freeway traffic from the US 95 to the parallel arterials. The following infrastructure would be required.

1. Surveillance
   - Detectors
   - CCTV

2. Traffic Control
   - Ramp Meters

3. Traveler Information
   - Changeable Message Signs
   - Trailblazer Signs
   - Highway Advisory Radio

1. Surveillance

Surveillance Systems provide a range of traffic flow information by using different technologies. This information includes speed, volume, density, travel time, queue length, occupancy, and vehicle position. These data are used in real-time for making traffic management decisions, such as selecting traveler information displays, implementing appropriate control strategies, incident detection, coordinating route, diversion, and establishing ramp metering rates. The data may also be stored as a historical record of traffic flow conditions.

Many of the surveillance technologies are proven and have been used in many ITS projects. For this project, the following infrastructure is recommended for traffic surveillance:

- Detectors
- Closed Circuit Television (CCTV)

Detectors

Detectors are commonly used for traffic surveillance. Traditionally, inductive loop detectors have been used extensively. An emerging technology using video imaging techniques is becoming more popular because of its portability and flexibility. Figure 5-11 shows the proposed detection locations for the US 95 Pilot Corridor.

Closed Circuit Television (CCTV)

CCTV cameras have been used to provide visual surveillance of many freeway systems in the country. Freeway surveillance systems are typically used to observe traffic conditions, identify and monitor incidents, and provide visual aid for developing suitable traffic management techniques. Figure 5-12 shows the proposed CCTV locations for the US 95 pilot corridor.

2. Traffic Control

Ramp Metering is a proven means of controlling traffic. Ramp metering controls the rate of traffic entering the freeway to maintain the maximum possible throughput in the mainline. This reduces the “friction” caused by traffic merging at the on-ramps and creating “shockwaves”, which are stop-and-go conditions that propagate upstream. Experiences in Minnesota and other states have shown that metered freeways can operate at capacities as high as 2700 vphpl. Figure 5-13 shows the proposed ramp metering locations for the US 95 pilot corridor.

While ramp metering is used primarily to reduce the impacts of recurring congestion, it can also be used to combat incident-related congestion. For example, metering rates upstream of the incident area could be reduced to limit the number of vehicles entering the freeway.

Although ramp metering can be used effectively to deal with mainline congestion, one common drawback happens when traffic queues extend back to block the upstream intersection. This happens when the arrival rate of traffic exceeds the metering rate. With the surface street intersections being signalized, this problem is compounded in two ways. Firstly, traffic signals work against ramp meters. Traffic signals are designed to allow traffic to progress in platoons, and platoons cause long queues at the ramps. Secondly, excessive queues blocking an upstream signalized intersection would ha-de a “queue collision” effect, compounding the speed of queue formation along the arterial. Much vocal opposition towards ramp meters are due to problems associated with this excessive queuing.

This queuing problem caused by ramp meters can be dealt with in two ways. Firstly, some agencies have installed a “flushing detector” at the end of the ramp. Whenever this detector is occupied, the ramp meter rate would be increased to the maximum to flush the queue at the ramp. Although this is useful in preventing queue spillback, it can create excessive demand on the mainline freeway and cause it to breakdown. In this case, the purpose of ramp metering is violated by flushing the ramp.

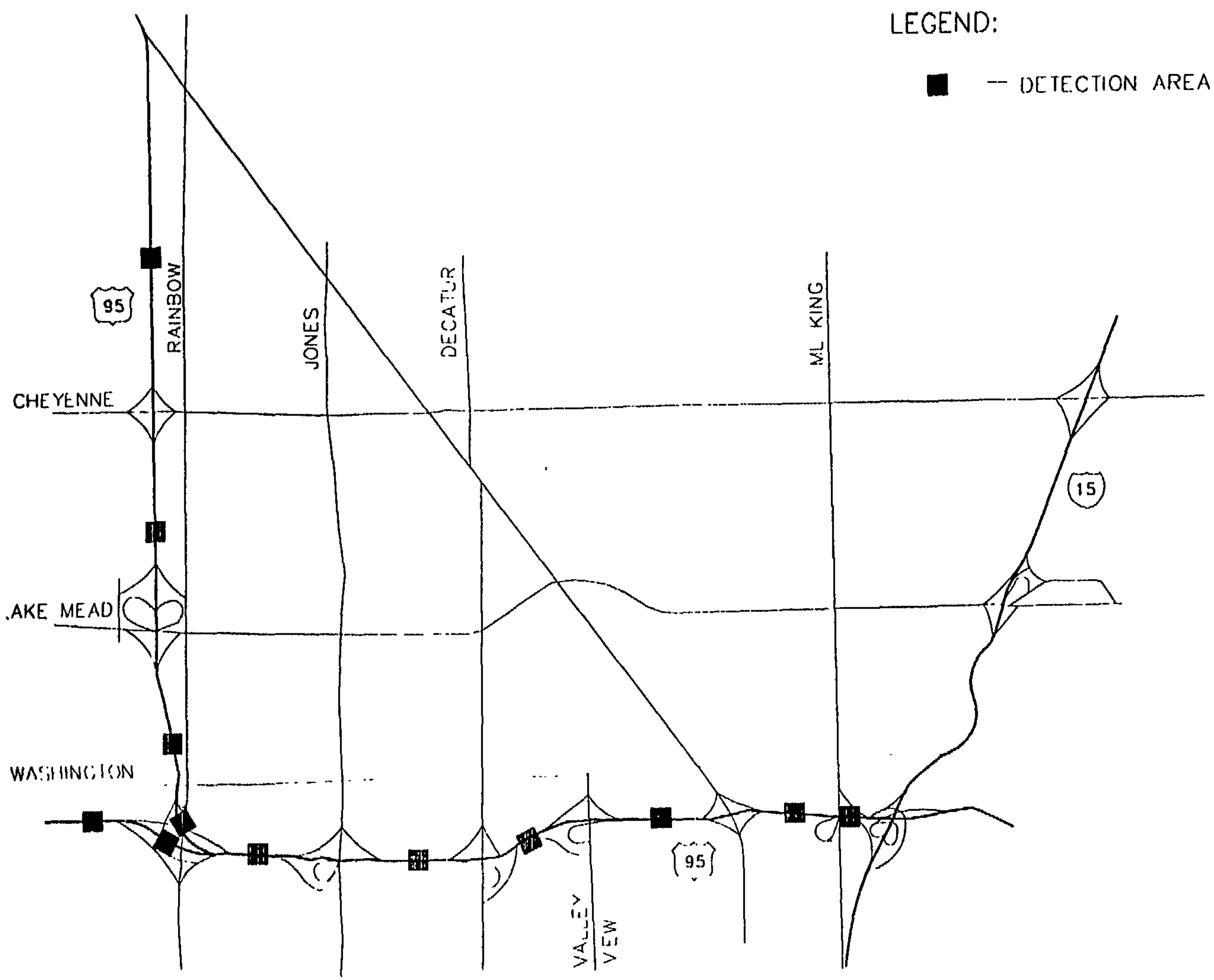


Figure 5-11
Proposed Detection System
US 95 Pilot Corridor

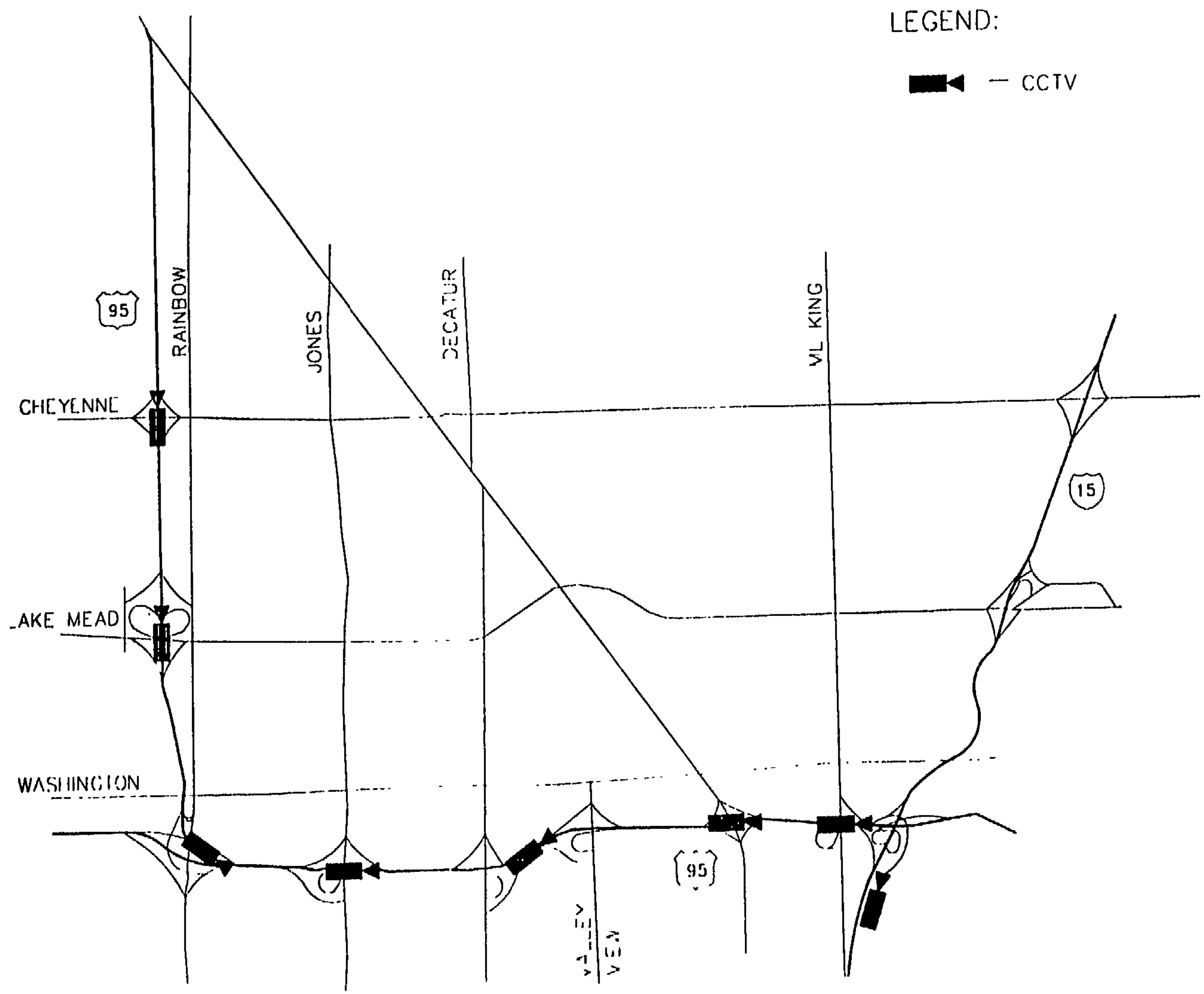


Figure 5-12
Proposed CCTV Locations
US 95 Pilot Corridor

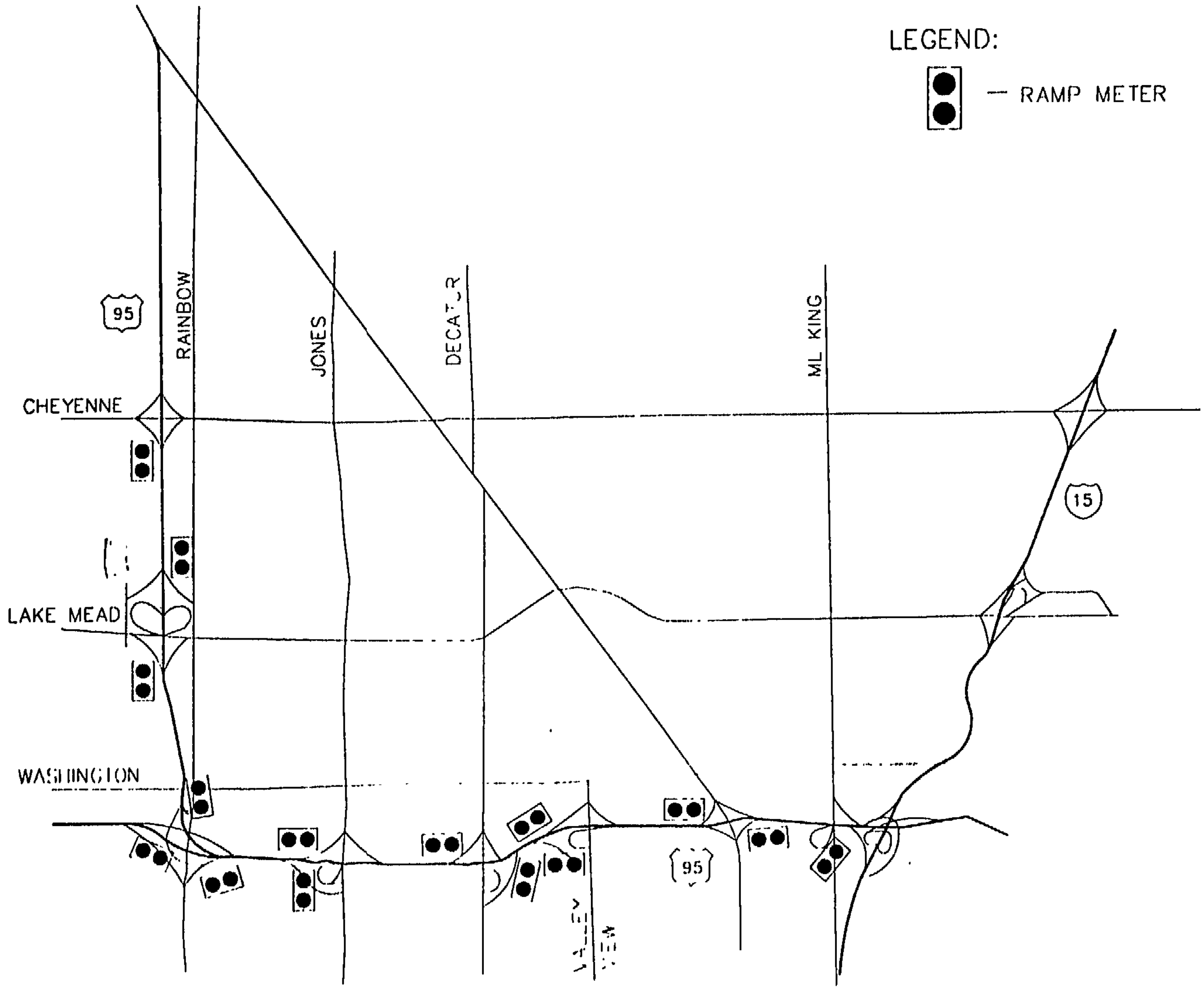


Figure 5-13
Proposed Ramp Metering Locations
US 95 Pilot Corridor

Another more proactive means of preventing queue back is through advising travelers to divert when the freeway and ramp capacity is exceeded. “Trailblazer signs” may be installed at the surface street arterials approaching the freeway. Before the demand exceeds the metering rates, these trailblazer signs can be turned on to direct traffic to an alternate route, bypassing the current on ramp or the freeway completely. This will also help to achieve the optimal balance of freeway and arterial corridor capacities.

3. Traveler Information

Changeable Message Signs and Trailblazer Signs provide current information to travelers. They are commonly used to warn travelers of congestion that lies ahead as a result of an incident, construction, maintenance, or special events. In addition, they can be used to provide route guidance to direct traffic to an alternate route.

Whereas changeable message signs provide traveler information to traffic on the freeway, trailblazer signs provide route guidance to traffic on surface arterials. These traveler information tools can be used effectively with ramp metering to balance the demand on the freeway and the parallel arterials. An example of how ramp metering works with trailblazer signs is shown in Figures 5-14 and 5-15.

Figures 5-16 and 5-17 show the proposed changeable message sign locations and trailblazer sign locations respectively for the US 95 Pilot Corridor.

Highway Advisory Radio (HAR) provide traveler information broadcasts to vehicles. The transmission range is typically limited to a few miles. Traveler information provided by these systems includes advisory information such as road closure, incidents, and special event information; safety and warning information such as severe weather (fog, ice, etc.) road hazards and safe speed; and traveler service information near major attractions.

Highway advisory radio provides a relatively economical means of disseminating a significant amount of information to the travelers. It is intended to provide more lengthy information than changeable message signs. Figure 5-18 shows the proposed HAR location for the US 95 Pilot Corridor

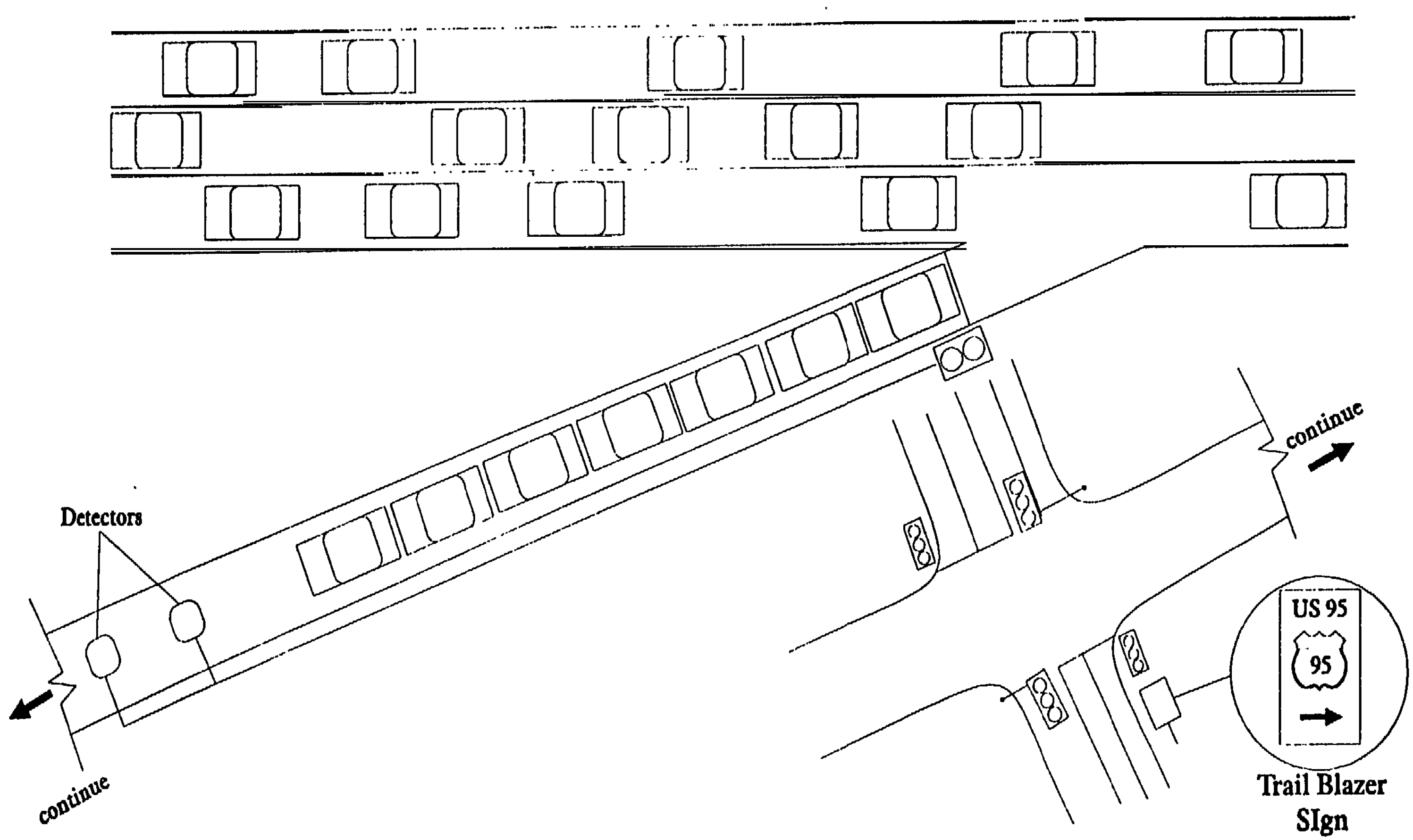


Figure 5-14
How Ramp Metering Works With Trailblazer Signs

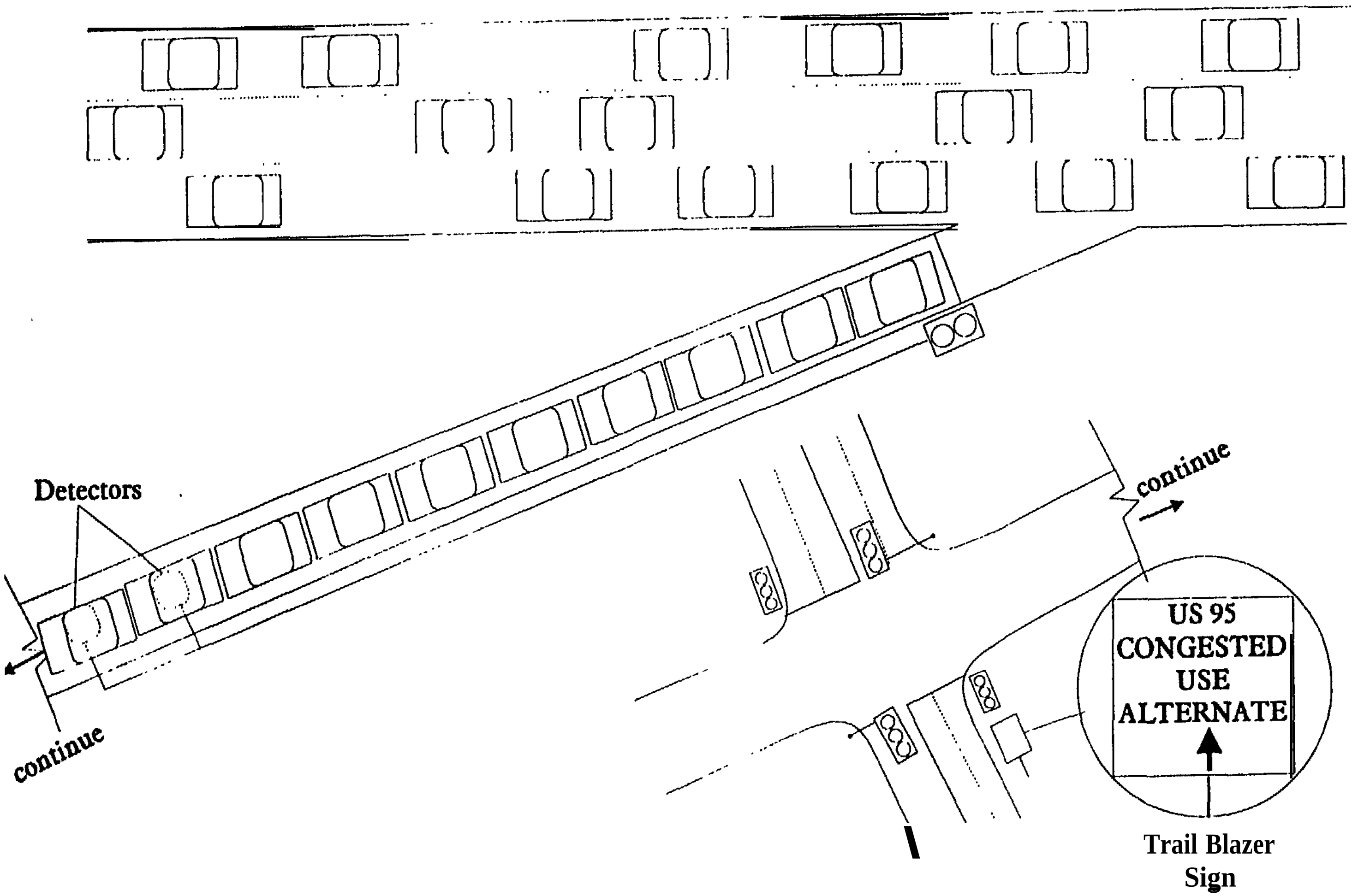


Figure 5-15
How Ramp Metering Works With Trailblazer Signs

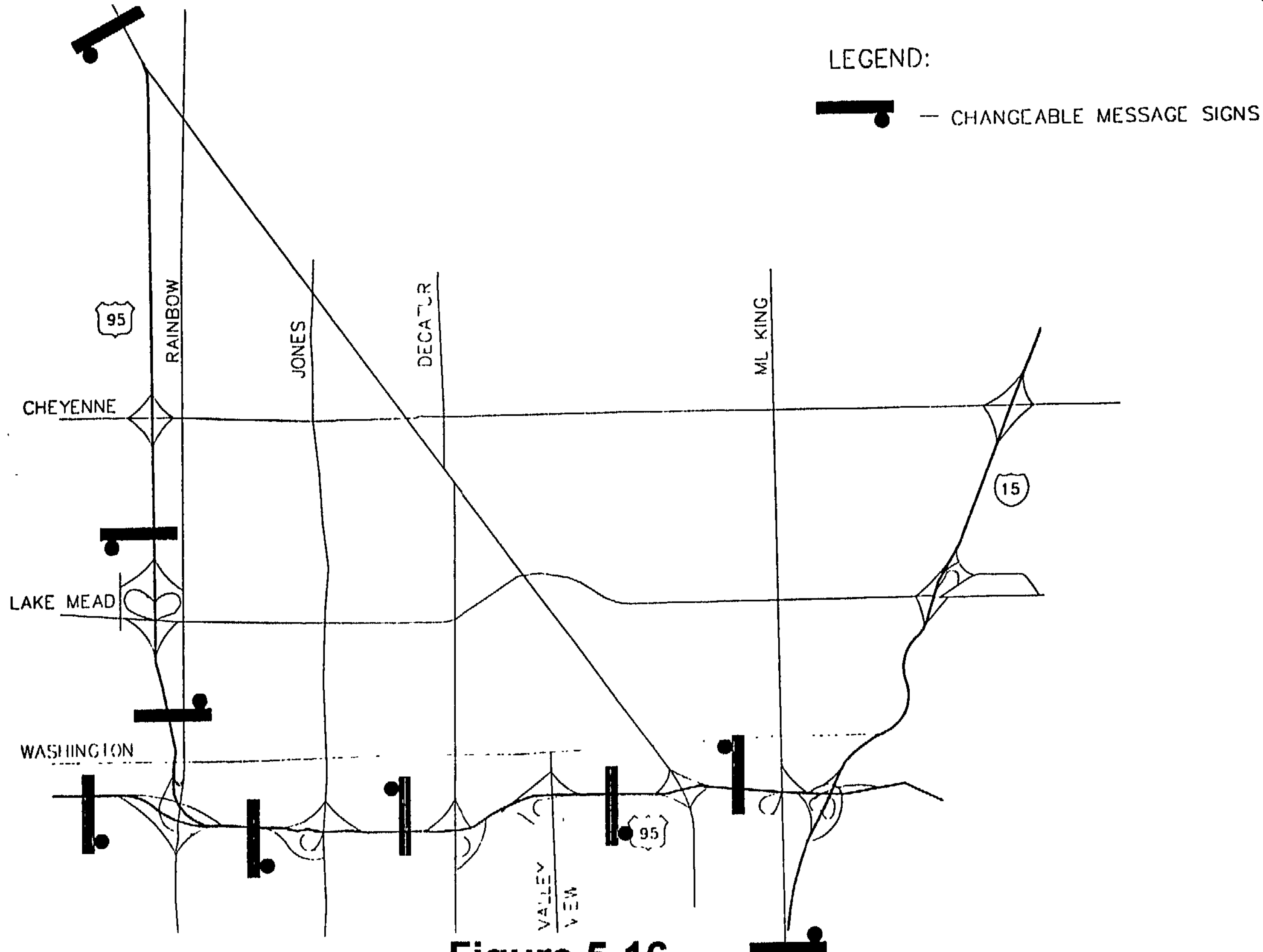


Figure 5-16
Proposed CMS Locations
US 95 Pilot Corridor

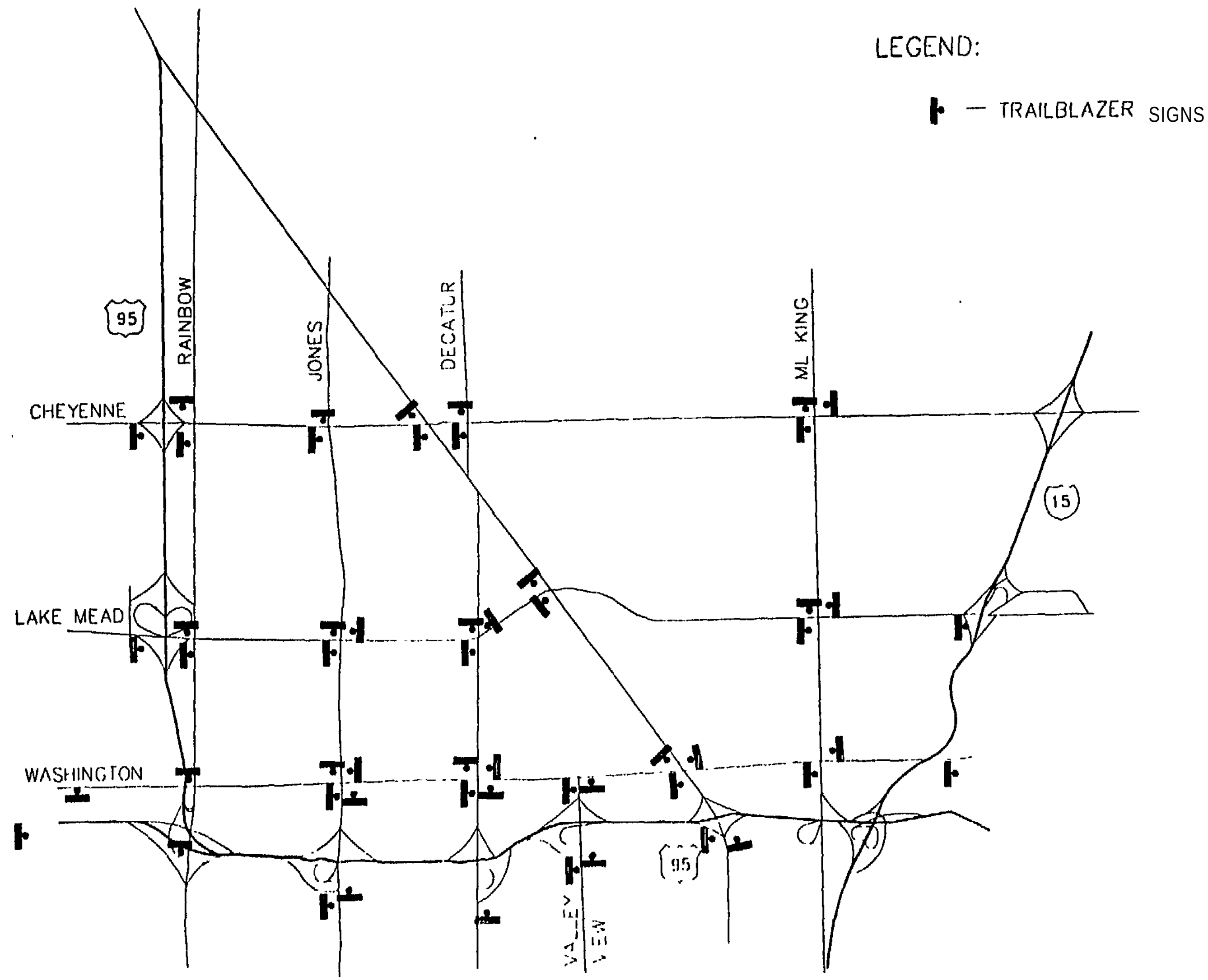


Figure 5-17
Proposed Trailblazer Sign Locations
US 95 Pilot Corridor

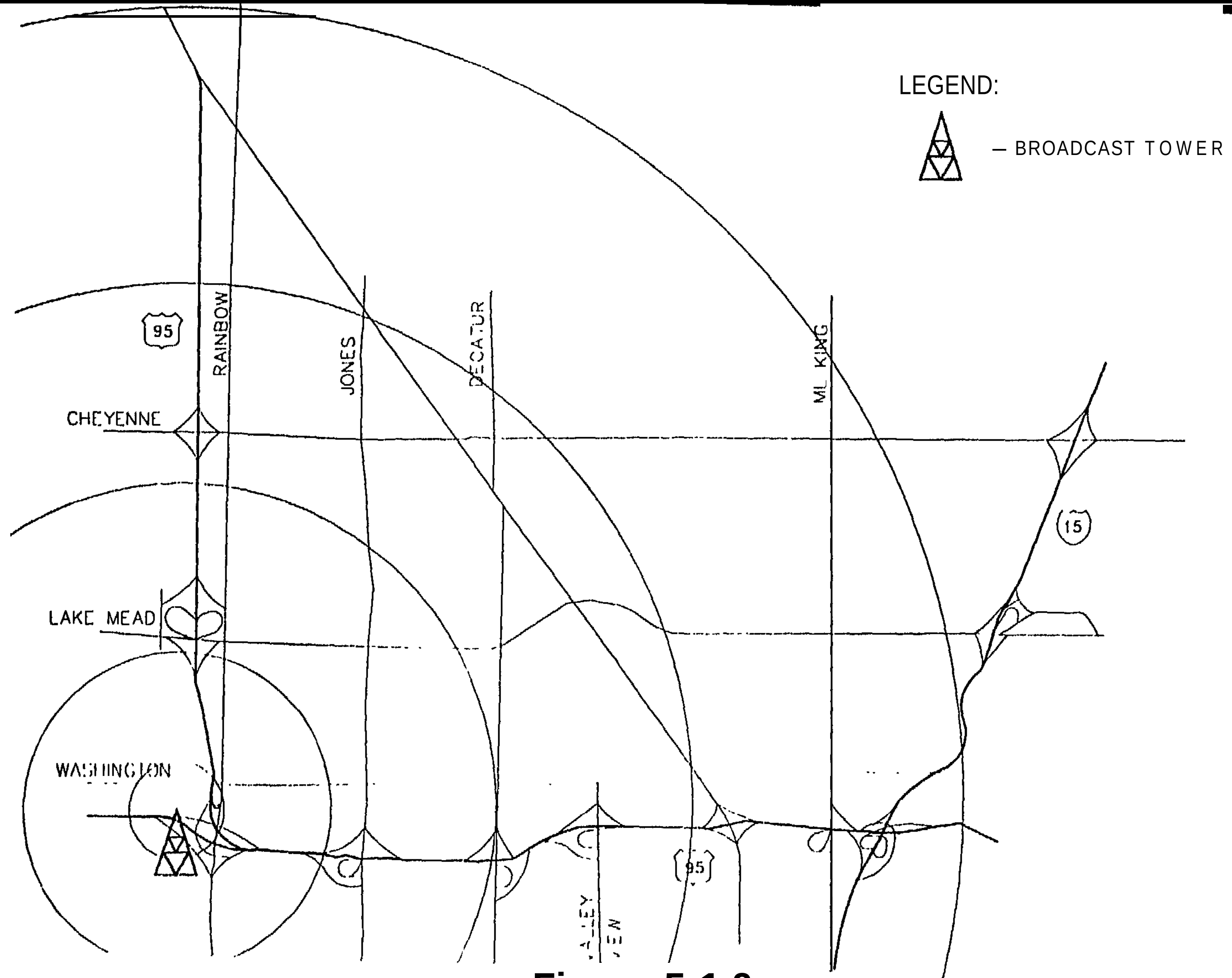


Figure 5-1 8
Proposed HAR Locations
US 95 Pilot Corridor

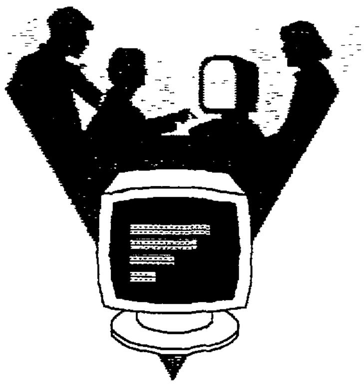
5.2.2 Cost of Deployment

The implementation of a freeway management system for the US 95 Pilot Corridor as an initial system, as described above, will cost approximately $4.9 million. This is summarized in Table 5.15.

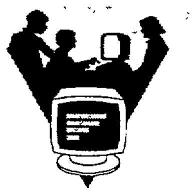
TABLE 5.15: US 95 Pilot Corridor Cost

Ramp Meters	800,000
Changeable Message Signs (CMS)	1,440,000
Trailblazer Signs	810,000
Highway Advisory Radio (HAR)	10,000
Closed Circuit Television (CCTV)	315,000
Detectors	65,000
Communications System	1 ,000,000
Traffic Management Center	500,000
TOTAL	**$ 4,940,000**

It should be noted that the above costs differ from that shown in Table 7.1 for US-95. The reason is that Table 7.1 shows the ultimate system costs for the corridor. The initial system shown above does not include all the instrumentation. For example, ramp metering at the on ramps north of Cheyenne is not included in this pilot system due to the very light volumes. In Table 7.1 such ramp metering is included for future expansion.



CHAPTER 6
SYSTEM ARCHITECTURE



6. SYSTEM ARCHITECTURE

6.1 What is a System Architecture?

System architecture is a framework that describes how system components interact and work together to achieve total system goals. It describes the system operation, what each component of the system does and what information is exchanged among the components. It defines the subsystems and the data flows (i.e., information that must be shared between subsystems) required to make ITS work. A thoughtfully designed architecture will ensure that the deployment of ITS services occurs within the most sensible system framework

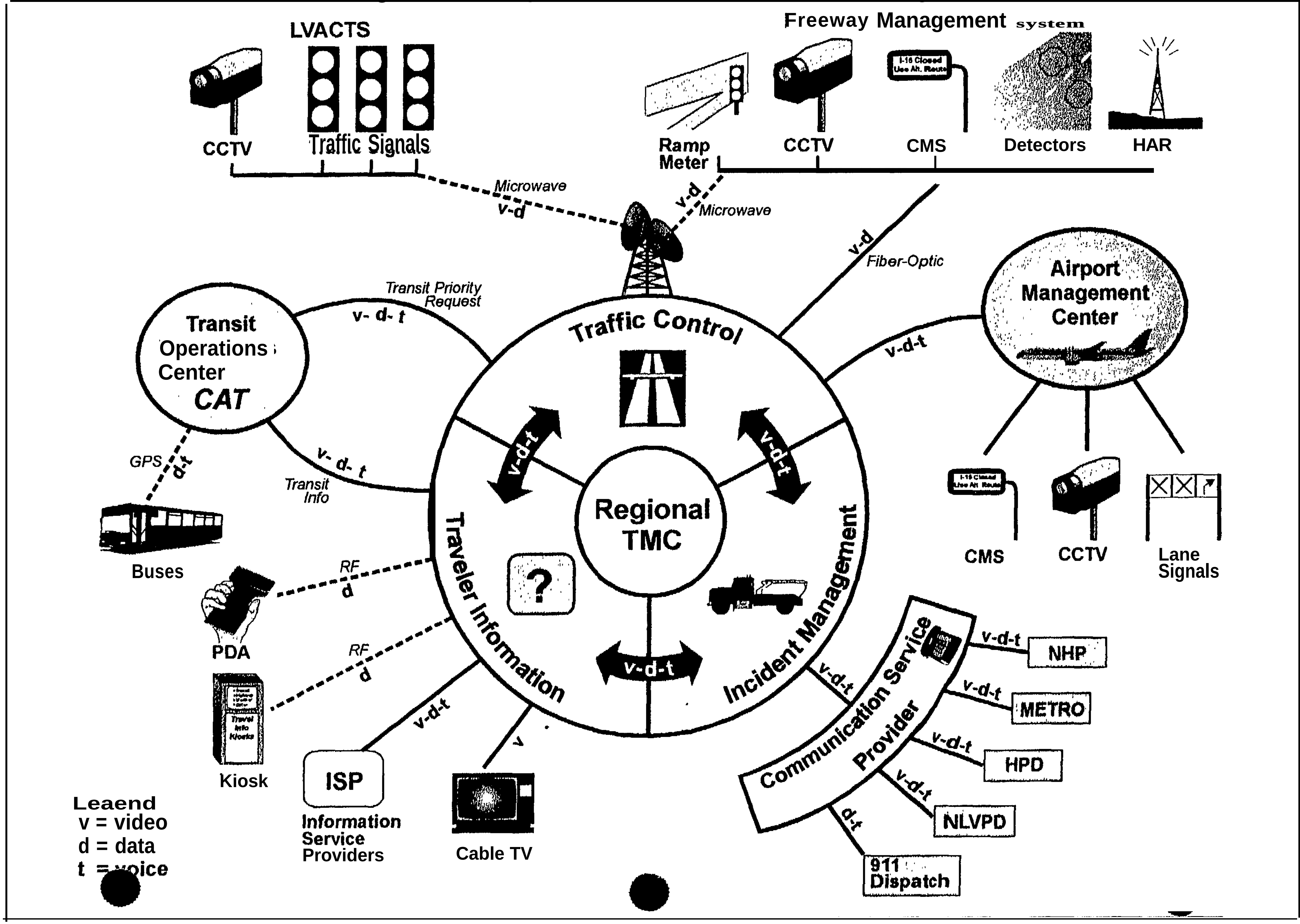
A system architecture is different from a system design. Within the framework of an architecture, many different designs can be implemented. Home stereo systems provide a good example of the importance of establishing an architecture. Consumers, or users, determine. what capabilities they want in a stereo system (e.g. compact disk, tape player or turntable) based on cost and performance. Since the home stereo industry has an established architecture, product suppliers offer components that consumers know will work together.

6.2 System Architecture for Las Vegas

The system architecture for Las Vegas shows the functionalities involved in performing the high priority programs, as shown in Figure 6.1.

At the center of the architecture is the Regional Traffic Management Center. It involves the three functions of traffic control, traveler information, and incident management. The traffic control function involves communication with LVACTS field infrastructure, namely traffic signals and CCTV cameras, and a Freeway Management System involving ramp meters, CCTV cameras, CMSs, detectors, and HAR. The communication system with LVACTS involves data and video transmission through microwave. The communication system with the freeway management system involves data and video transmission through both fiber-optic cables and microwave.

Figure 6.1 System Architecture for Las Vegas



The traveler information function involves providing traveler information to the public through a number of channels. A Cable TV Traveler Information System obtains traveler information in the form of video transmission from the database residing in the regional TMC to cable TV subscribers. Similar data and video transmission can also be provided to information service providers (ISP), private companies that package and add value to the traveler information to sell to the public. Some ISP may utilize kiosks and personal data assistants (PDAs) to provide data to the public.

The incident management function involves communicating with the agencies involved in the Incident Management System. These include the Nevada Highway Patrol, METRO, Henderson Police, North Las Vegas Police, and the 911 dispatch center. Communications with these agencies may take the form of video, data and voice communication. Coordination with the Freeway Service Patrol is also one of the functions.

Besides the three functions, the regional TMC also communicates with the Transit Operations Center and the Airport Operations Center. Through the Transit Information System, transit information is transmitted in the form of data to the traveler information system. At the same time, the transit operations center can communicate with the regional TMC to request video transmission of particular locations to observe bus operations. Through the AVL system, the location of every bus can be seen in the transit operations center. If any buses are behind schedule, the transit operators can request the LVACTS operators to provide partial priority to that particular bus in order to allow it to catch up.

The communication with the airport management center will facilitate sharing of video and data regarding traffic conditions around and within the airport complex. This will allow the regional TMC to implement proper traffic management and traveler information techniques to improve airport access. Also, flight information can be provided to the traveler information system and displayed on the cable TV channel.

6.3 Compatibility with the National System Architecture

The Federal Highways Administration has undergone a two year project to develop a national system architecture for ITS. At the time of writing this report, the work is almost complete.

Although this project was performed in parallel with the national ITS architecture development, the Las Vegas System Architecture was developed with the premise of being compatible with the national system architecture. Figure 6-2 shows the subsystem interconnect relationships of the national system architecture. Figure 6-3 shows a similar subsystem diagram for the Las Vegas system architecture.

The "Center Subsystems" of the Las Vegas architecture contains four elements, namely the regional TMC, the transit operations center, the airport operations center, and the information service provider. These centers communicate with the "Roadside Subsystems" through wireline communications. The term wireline communications here includes point to point wireless communications such as microwave. The roadside subsystems are the field infrastructure for LVACTS and the freeway management system. The "Traveler Subsystems" include the interfaces with the travelers. For Las Vegas, this includes Cable TV, which is communicating directly with the wireline communications, and other means such as PDAs and kiosks, which are communicating through a wide area wireless communication means. The "Vehicle Subsystems" include vehicles, buses, and emergency vehicles, which communicate through the wireless communication means. Within this plan, there is no dedicated short-range communications between the roadside subsystems and the vehicle subsystems, and no vehicle to vehicle communications. However, this architecture is open for adding these two communication media in future .

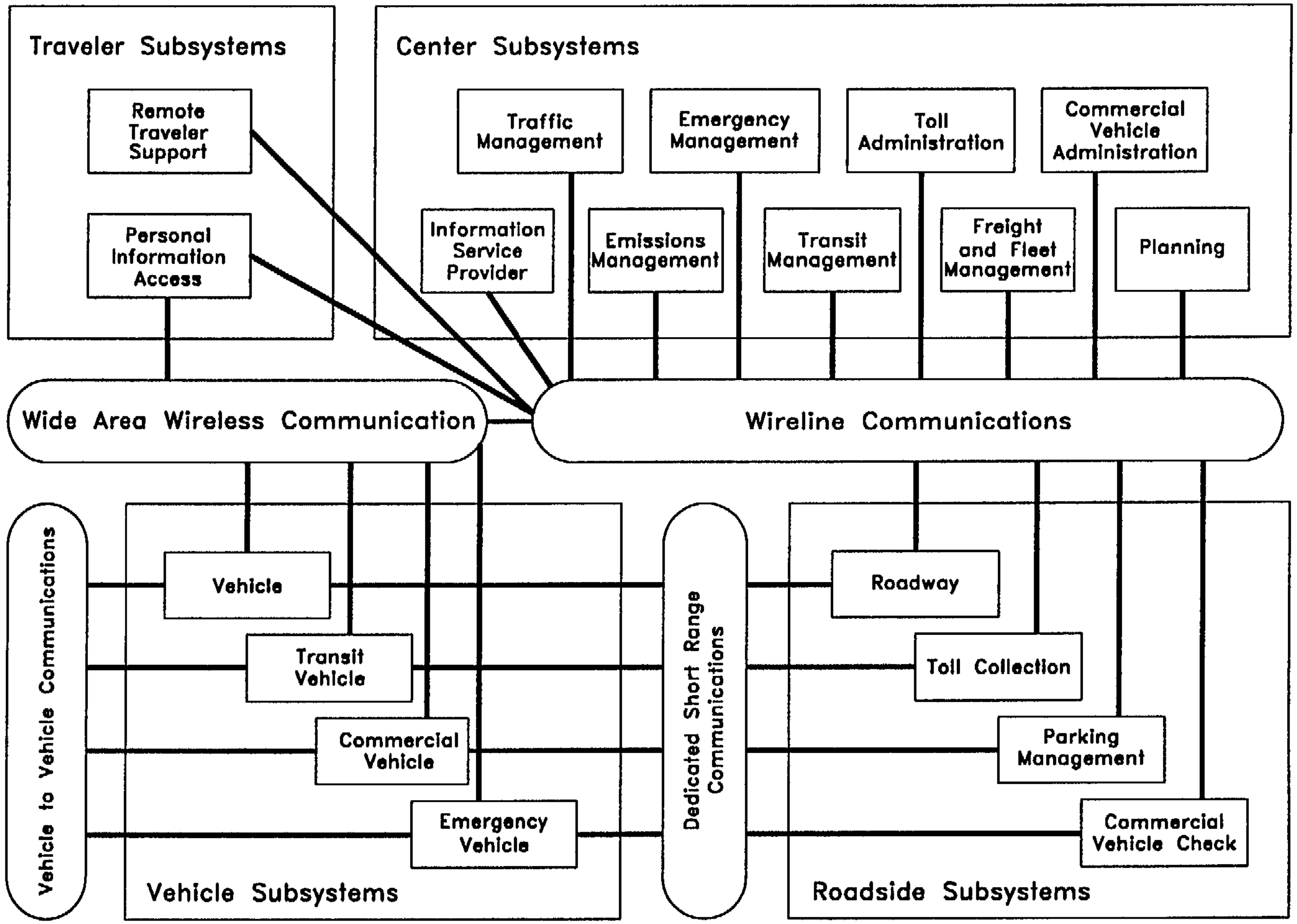


Figure 6-2
National System Architecture Subsystems Interconnect Diagram

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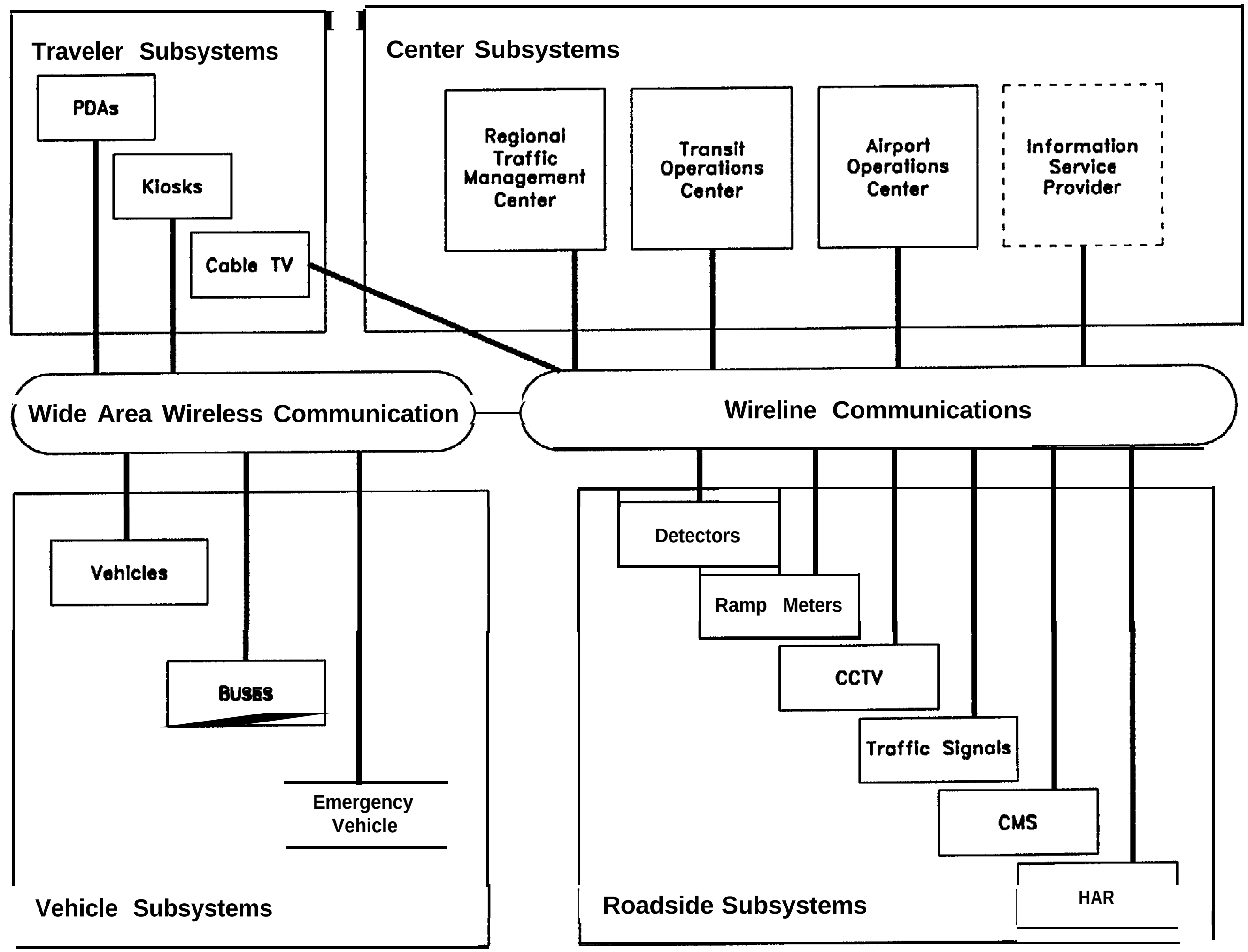

Figure 6-3
Architecture Subsystems
Interconnect Diagram for Las Vegas

CELAPTER 7
PROJECT IMPLEMENTATION

7. PROJECT IMPLEMENTATION

7.1 Project Phasing

The high priority program areas for Las Vegas ITS implementation were discussed in Chapter 3, and their benefits were evaluated in Chapter 4. This chapter discusses the phasing of these programs, outlines the implementation activities, summarizes annual capital and operations/maintenance cost estimates, and identifies potential funding sources. It also discusses the possible roles of the private sector.

As mentioned in Chapter 3, the RTC had approved the following eight high priority program areas for implementation within the next five years:

- Regional Traffic Management Center
- Freeway Management System
- Incident Management System
- Service Patrol on Freeways
- Cable TV Traveler Information System
- Automatic Incident Detection on Freeways
- Accident Investigation Sites on Freeways
- Transit Information System

Each of these program areas were segregated into projects and activities for deployment. The activities and cost of deployment of these projects are summarized in Tables 3.3 to 3.10. They are combined and presented in Table 7.1.

7.1.1 Project Implementation Workshop

A workshop was held with the Steering Committee and some members of the working groups in July 1996 to prioritize the project implementation activities. Each workshop participant took part to prioritize the sequence of implementation of each project and activity. The aggregate sequences were used to determine the priority of implementation.

Based on a five year implementation timeframe, the sequence of project implementation are then divided into activities for each of the five year. This is summarized in Table 7.2. This table can be used to guide the planning of activities necessary for implementation.

TABLE 7.1: Summary of Project Activies and Costs

Program Area	Projects	Activities		COSTS (In $1000) Transportation Related Capital	% Hwy	% Transit	Annual O&M
1.0	**Regional Traffic Management Center**			**3450**	**98%**	**2%**	**680**
	1.0.1		Expand LVACTS to include Freeway Management System	2200	100%	0%	410
		1.0.1.1	Architectural improvements to LVACTS	200	100%	0%	10
		1.0.1.2	Additional Staff	0	100%	0%	200
		1.0.1.3	Hardware and software improvements in TMC	2000	100%	0%	200
	1.02		Expand TMC to include Traveler Information System	1050	93%	7%	160
		1.0.2.1	Media Activities	50	100%	0%	10
		1.0.2.2	Additional Staff	0	100%	0%	50
		1.0.2.3	Develop Regional Database	1000	80%	20%	100
	1.0.3		Expand TMC to include Incident Management System	200	100%	0%	110
		1.0.3.1	Communication with Police	200	100%	0%	60
		1.0.3.2	NHP Staff in LVACTS	0	100%	0%	50
2.0	**Freeway Mangaement System**			**26534**	**100%**	**0%**	**1309**
	2.1		Ramp Metering System (RMS)	3900	100%	0%	177
		2.1 .1	Procure initial ramp meter system for US 95	1140	100%	0%	57
		2.1.2	Integrate initial system with freeway management system and LVACTS	360	100%	0%	0
		2.1.3	Expand ramp metering to I-I 5 and Airport Expressway	1140	100%	0%	57
		2.1.4	Expand ramp metering to US 93/95	1140	100%	0%	57
		2.15	Expand ramp metering to Beltway	120	100%	0%	6
	2.2		Closed Circuit Television Cameras (CCTV)	4602	100%	0%	230
		2.2.1	Procure initial CCTV system for US 95	858	100%	0%	43
		2.2.2	Expand CCTV to I-15 and Airport Expressway	1404	100%	0%	70
		2.2.3	Expand CCTV to US 93/95	1092	100%	0%	55
		2.2.4	Expand CCTV to Beltway	1248	100%	0%	62

TABLE 7.1: Summary of Project Activies and Costs

Program Area	Projects	Activities		COSTS (In $1000)			
				Transportation Related Capital	% Hwy	% Transit	Annual O&M
2.3			Changeable Message Signs (CMS)	4032	100%	0%	202
	2.3.1		Procure initial CMS system for US 95	1728	100%	0%	86
	2.3.2		Expand CMS to I-15 and Airport Expressway	768	100%	0%	38
	2.3.3		Expand CMS to US 93/95	768	100%	0%	38
	2.3.4		Expand CMS to Beltway	768	100%	0%	38
2.4			Highway Advisory Radio (HAR)	36	100%	0%	2
	2.4.1		Procure initial HAR system for US 95	12	100%	0%	1
	2.4.2		Expand HAR to I-15 and Airport Expressway	12	100%	0%	1
	2.4.3		Expand HAR to US 93/95	0	100%	0%	0
	2.4.4		Expand HAR to Beltway	12	100%	0%	1
2.5			Detection	312	100%	0%	16
	2.5.1		Procure initial detection system for US 95	78	100%	0%	4
	2.5.2		Expand detection to I-15 and Airport Expressway	72	100%	0%	4
	2.5.3		Expand detection to US 93/95	60	100%	0%	3
	2.5.4		Expand detection to Beltway	102	100%	0%	5
2.6			Communication System	8880	100%	0%	444
	2.6.1		Procure initial communication system for US 95	1200	100%	0%	60
	2.6.2		Expand communication to I-15 and Airport Expressway	2880	100%	0%	144
	2.6.3		Expand communication to US 93/95	1680	100%	0%	84
	2.6.4		Expand communication to Beltway	3120	100%	0%	156
2.7			Install trailblazer signs	4772	100%	0%	239
	2.7.1		Procure initial trailblazer signs for US 95	972	100%	0%	49
	2.7.2		Expand trailblazer signs to I-15 and Airport Expressway	1300	100%	0%	65
	2.7.3		Expand trailblazer signs to US 93/95	1200	100%	0%	60

TABLE 7.1: Summary of Project Activies and Costs

Program Area	Projects	Activities		COSTS (In $1000) Transportation Related Capital	% Hwy	% Transit	Annual O&M
	2.7.4		Expand trailblazer signs to Beltway	1300	100%)	0%	65
3.0			**Incident Management System**	**1625**	**90%**	**10%**	**115**
	3.0.1		Develop pre-planned detour routes	100	90%	10%	5
	3.0.2		Change legislation to allow expeditious clearance	0	-	-	0
	3.0.3		Install magnetic strip on Nevada drivers license	0		-	0
	3.0.4		Change legislation to allow self-reporting of non-injury incidents	0		-	0
	3.0.5		Establish task force to consolidate accident report	0			0
	3.0.6		Install regional accident database	200	90%	10%	10
	3.0.7		Provide common radio channel and cellular nhnnes	1000	90%	10%	0
	3.0.8		Enhance equipment and staffing for NDOT emergency response team	300)	90%	10%	100
	3.0.9		Standardize milepost for state facilities	25	90%	10%	0
4.0			**Service Patrols on Freeways**	**80**	**100%**	**0%**	**550**
	4.0.1		Install service patrols on US 95 peak - private sector	50	100%	0%	300
	4.0.2		Install service patrols regionwide peak - private sector	30	100	0%	250
5.0			**Cable TV Traveler Information System**	**150**	**80%**	**20%**	**25**
		5.0.0.1	Develop interface to regional Traveler Information database	150	80%	20%	10
		5.0.0.2	Provide graphical display & CCTV images to cable TV	0	-	-	15
6.0			**Automatic Incident Detection on Freeways**	**735**	**90%**	**10%**	**60**
	6.0.1		AID for US 95 Pilot Corridor	265	90%	10%	15
		6.0.1.1	Develop or procure automatic incident detection algorithm	100	90%	10%	0
		6.0.1.2	Install additional detectors on freeways	65	90%	10%	5
		6.0.1.3	Integrate AID into freeway management system	100	90%	10%	10

TABLE 7.1: Summary Project Activies and Costs

Program Area	Projects	Activities		COSTS (In $1000) Transportation Related Capital	% Hwy	% Transit	Annual O&M
	6.0.2	AID for I-15 Corridor		150	90%	10%	15
		6.0.2.1	Install additional detectors on freeways	100	90%	10%	5
		6.0.2.2	Integrate AID into freeway management system	50	90%	10%	10
	6.0.3	AID for US 93/95 Corridor		170	90%	10%	15
		6.0.3.1	Install additional detectors on freeways	120	90%	10%	5
		6.0.3.2	Integrate AID into freeway management system	50	90%	10%	10
	6.0.4	AID for Beltway Corridor		150	90%	10%	15
		6.0.4.1	Install additional detectors on freeways	100	90%	10%	5
		6.0.4.2	Integrate AID into freeway management system	50	90%	10%	10
7.0	**Accident Investigation Sites on Freeways**			**1700**	**100%**	**0%**	**0**
	7.0.1	Accident investigation sites on US 95		300	100%	0%	0
	7.0.2	Accident investigation sites on I-15 and Airport Expressway		600	100%	0%	0
	7.0.3	Accident investigation sites on US 93/95		400	100%	0%	0
	7.0.4	Accident investigation sites on Beltway		400	100%	0%	0
8.0	**Transit Information System**			**8350**	**0%**	**100%**	**415**
	8.0.1	Provide AVL for buies		3000	0%	100%	150
	8.0.2	Upgrade transit operation system to provide individual bus schedules		2800	0%	100%	140
	8.0.3	CMS at bus stops for bus arrival information		2000	0%	100%	100
	8.0.4	Bus operations interface with LVACTS for video transmission		50	0%	100%	0
	8.0.5	Smart Cards		500	0%	100%	25
			OVERALL TOTAL	**42624**	**82%**	**18%**	**3154**

Table 7.2: Summary of Project Implementation Sequence

Project			Year	CAPITAL COSTS ($1000)					ANNUAL O&M COSTS ($1000)			
		Transportation Related Capital Costs $1000		Freeway Projects	Non-Freeway Projects	Transit Projects	Other	Annual O&M	Freeway Projects	Non-Freeway Projects	Transit Projects	Other
4.0.1	Install service patrols on US 95 peak-private sector	50	1	50				300	300			
2.1.1	Procure initial ramp meter system for US 95	1,140	1	1140				57	57			
3.0.5	Establish task force to consolidate accident report	-	1	-				0				
8.0.1	Provide AVL for buses	3,000	1			3,000		150			150	
2.6.1	Procure initial communication system for US 95	1.200	1	1.200				60	60			
2.2.1	Procure initial CCTV system for US 95	850	1	850				43	43			
2.3.1	Procure initial CMS system for US 95	1,728	1	1,728				86	86			
2.5.1	Procure initial detection system for US 95	78	1	78				4	4			
2.4.1	Procure initial HAR system for US 95	12	1	12				1	1			
2.1.2	Integrate initial system with freeway management system and LVACTS	360	1	180	180			0	-			
1.0.1a	Expand LVACTS to include freeway management system	1,100	1		1,100							
	TOTAL YEAR 1	**9,526**		**5,246**	**1,280**	**3,000**	**-**	**701**	**551**		**150**	
1.0.1b	Expand LVACTS to include freeway management system	1,100	2	1,100				410	410			
3.0.2	Change legislation to allow expeditious clearance	-	2					0				
3.0.1	Develop preplanned detour routes	100	2	100				5	5			
3.0.4	Change legislation to allow self-reporting of non-injury incidents	-	2					0				
3.0.10	Standardize milepost for state facilities	25	2			25		0				
7.0.1	Accident investigation sites on US 95	300	2	300				0				
1.0.2	Expand TMC to include Traveler Information System	1,050	2		1,050			160		160		
1.0.3	Expand TMC to include Management System	200	2		200			110		110		
2.7.1	Procure initial trailblazer signs for US 95	972	2	486	486			49	24	24		
5.0	Cable TV Traveler Information System	150	2		150			25		25		
3.0.6	Install regional accident database	200	2		200			10		10		
3.0.7	Provide common radio channel and cellular phones	1,000	2			1,000		0				
3.0.8	Enhance equipment and staffing for NDOT emergency response team	300	2	300				100	100			
8.0.2	Upgrade transit operation system to provide individual bus schedules	2,800	2					140			140	
	TOTAL YEAR 2	**8,197**		**2,286**	**2,086**	**1,025**		**1,009**	**539**	**329**	**140**	
8.0.3	CMS at bus stops for arrival information	2,000	3			2,000		100			100	
8.0.4	Bus operations interface with LVACTS for video transmission	50	3			50		0			-	
2.6.2	Expand communication to I-15 and Airport Expressway	2,880	3	2,880				144	144			
2.2.2	Expand CCTV to I-15 and Airport Expressway	1,404	3	1,404				70	70			
2.1.3	Expand ramp metering to I-15 and Airport Expressway	1,140	3	1,140				57	57			
4.0.2	Install service patrolsregionwide peak - private sector	30	3	30				250	250			
2.3.2	Expand CMS to I-15 and Airport Expressway	768	3	768				38	38			
2.4.2	Expand HAR to I-15 and Airport Expressway	12	3	12				1	1			
2.5.2	Expand detection to I-15 and Airport Expressway	72	3	72				4	4			
2.7.2	Expand trailblazer signs to I-15 and Airport Expressway	1,300	3	650	650			65	33	33		
	TOTAL YEAR 3	**9,656**		**6,956**		**2,050**		**729**	**596**	**33**	**100**	

Table 7.2: Summary of Project Implementation Sequence

Project		Transportation Related Capital Costs $1000	Year	CAPITAL COSTS ($1000) Freeway Projects	Non-Freeway Projects	Transit Projects	Other	Annual O&M	ANNUAL O&M COSTS ($1000) Freeway Projects	Non-Freeway Projects	Transit Projects	Other
7.0.2	Accident Investigation sites on I-15 and Airport Freeway	600	4	600				0	-			
2.6.3	Expand communication to US 93/95	1,680	4	1,680				84	84			
2.1.4	Expand ramp metering to US 93/95	1,140	4	1,140				57	57			
2.2.3	Expand CCTV to US 93/95	1,092	4	1,092				55	55			
2.3.3	Expand CMS to US 93/95	768	4	768				38	38			
2.5.3	Expand detection to US 93/95	60	4	60				3	3			
2.7.3	Expand trailblazer to US 93/95	1,200	4	1,200				60	60			
7.0.3	Accident investigation sites on US 93/95	400	4	400				0	-			
2.4.3	Expand HAR to US 93/95	-	4					0	-			
7.0.4	Accident investigation sites on Beltway	400	4	400				0	-			
	TOTAL YEAR 4	**7,340**		**7,340**				**297**	**297**			
2.6.4	Expand communication to Beltway	3,120	5		3,120			156		156		
2.2.4	Expand CCTV to Beltway	1,248	5		1,248			62		62		
2.1.5	Expand ramp metering to Beltway	120	5		120			6		6		
2.5.4	Expand detection to Beltway	102	5		102			5		5		
2.3.4	Expand CMS to Beltway	768	5		768			38		38		
2.4.4.	Expand HAR to Beltway	12	5		12			1		1		
2.7.4	Expand trailblazer signs to Beltway	1,300	5		1,300			65		65		
8.0.5	Smart Cards	500	5			500		25			25	
3.0.3	Install magnetic strips on Nevada drivers license	-	5					0				
6.0.1	AID for US 95 Pilot Corridor	265	5	265				15	15			
6.0.2	AID for I-15 Corridor	150	5	150				15	15			
6.0.3	AID for US 93/95 Corridor	175	5	175				15	15			
6.0.4	AID for Beltway Corridor	150	5	150				15	15			
	TOTAL YEAR 5	**7,905**		**735**	**6,670**	**500**		**419**	**60**	**334**	**25**	

7.1.2 Cost of Implementation

For funding purposes, the cost of implementation shown in Table 7.2 was further divided into four categories:

- **Freeway related projects** Funding of these projects is likely to come from NDOT.
- **Non-freeway related projects** - Funding of these projects need to come from the local agencies such the RTC, Clark County and the cities.
- **Transit related projects -** Funding of these projects are likely to come from transit sources managed by the RTC.
- **Other projects-** Funding of these projects are likely to come from other agencies, such as the police, since these activities are not part of transportation funding.

The lead funding agencies should take advantage of any opportunities for ITS implementation as part of the other transportation projects, such as the Beltway construction, LVACTS upgrade, other "super arterial" and so on. It is further recommended that the RTC Operations Subcommittee be established as the formal agency in the region to coordinate all local ITS initiatives in order to ensure synergism and reduce implementation costs.

The cost of implementation by year is further summarized in Table 7.3 below:

TABLE 7.3: Cost of Implementation (In $1000)
High Priority Program Areas

Project Nature	1997	1998	1999	2000	2001	Total
Freeway related projects	5,246	2,286	6,956	7,340	735	22,563
Non-freeway related projects	1,280	2,086	650	-	6,670	10,686
Transit related projects	3,000	2,800	2,050	-	500	8,350
Other projects		1,025	-	-	-	1,025
Total	9,526	8,197	9,656	7,340	7,905	42,624

7.2 Funding Sources

Traditionally, project funding for Las Vegas is controlled by the following sources:

- NDOT
- RTC
- Local County and cities

7.2.1 NDOT funding

NDOT controls the state funding, including the federal moneys allocated through the National Highways System (NHS), the Surface Transportation Program (STP), and bridge programs, plus state motor fuel tax.

1. **NHS funds** - The state obtains annual funding from the federal government under this program. However, all the moneys in the near future are bonded .

2. **State motor fuel tax** - About $200 to $250 million per year statewide is available from motor fuel tax for transportation purposes. This is a potential source of ITS capital funding. However, it needs to compete with the other highway infrastructure development and maintenance programs.

7.2.2 RTC funding

RTC has the following major funding sources:

1. **Local fuel tax -** A 9 cents per gallon local fuel tax amounts to $30 to $35 million per year for Clark County jurisdictions. This money is for highway construction only and cannot be used for operations. It is distributed to the local agencies annually. Locally, the county and the cities submit projects within RTC approval guidelines. With the agreement of all the local agencies, a certain amount could be set aside per year for funding ITS.

2. **Local sales tax** - This money is dedicated for mass transit. It is not available for funding general purpose ITS projects or activities.

3. **CMAQ funds** - This amounts to about $3 million per year. It can be used for ITS purposes

4. **STP funds** - The state and local STP funds amount to $15 to $18 million per year for the Las Vegas Valley. These funds can be used for ITS implementation purposes. The LVACTS upgrade project obtained $6 million from this funding source

3. **Real property/development tax and motor vehicle privilege tax -** These moneys are allocated to Clark County and are designated for Beltway use only. Those ITS projects related to the Beltway can potentially be funded from this source.

4. **Resort corridor room tax** - This money is allocated to Clark County and the City of Las Vegas and is used for resort corridor improvement projects only. Those ITS projects related to the resort corridor can potentially be funded from this source.

5. **FTA Section 9** - This is called "formula money" for transit purposes only. Each year, Congress allocates these money to transit agencies based on population, miles of fixed route, etc. The transit agency need to prepare a short range transit plan, a Regional Transportation Plan (RTP), etc. There are three categories within this pool: Capital, Operating and Planning. Capital and Planning have a 20% local match requirement. Operating has a 50% local match requirement up to a maximum yearly cap of approximately $1.2 million. This grant can be used to purchase capital equipment for bus operations, including ITS elements. RTC has allocated part of the $9 million grant for 96-97 to be used for the procurement of a communications system and AVL for buses and paratransit. In July, 1996, RTC issued an RFP for a Communications Master Plan feasibility study. Historically, the grant and local match amounts are summarized in Table 7.4:

TABLE 7.4
FTA Section 9 Grant and Local Match

Year	FTA Grant	Local Match	Total
1993-94	$8,423,221	$7,320,614	$15,743,835
1994-95	$5,325,830	$9,856,770	$15,812,600
1995-96	$6,443,595	$7,537,486	$13,981,081
budget for next year (pending approval):			
1996-97	$9,870,000	$2,467,000	$12,337,000

6. **FTA Section 3** - These grants are appropriated by Congress for light rail and other major transit infrastructure. It cannot be used for ITS purposes.

7.2.3 Local County and Cities funding

Clark County and the cities obtain funding from their local sales tax and general appropriations. These moneys are typically used for operations and maintenance of existing facilities. The operations of LVACTS is through a co-operative agreement

7.2.4 Federal funding

With the expiration of ISTEA in 1997, the future of federal funding of ITS projects is uncertain. Federal Highways Administration (FHWA) has issued in 1996 a request for proposal (RFP) for "Model Deployment of ITS." It is expected that two or three major cities will obtain federal funding in the range of $10 to $20 million for model deployment. FHWA may continue to issue new RFP for model deployment in future If so, this ITS early deployment plan should be used to help Las Vegas seek such funding.

U S Secretary of Transportation Federico Pena announced a program called "Operations Timesaver" in January 1996. The intent is to reduce the commute time in each of the top 75 metropolitan cities in the United States by 15%. So far, no detailed funding program has been announced. Some expect that the next ISTEA bill may contain dedicated ITS funding sources in order to implement "Operations Timesaver". If this is the case, Las Vegas should actively seek this funding for the ITS deployment program.

7.3 Longer Term Programs

Beyond the five year timeframe, Las Vegas should continue to aggressively implement ITS. Since the technology advances and local transportation needs cannot be predicted so far into the future, this strategic plan does not elaborate on the implementation program beyond five years. However, it is strongly suggested that this ITS Strategic Plan be updated every five years. Similar to urban planning, one would need to prepare a general plan update every five years or so. It is even more true for ITS. Because ITS deployment is so new, the public's response to the first five year program will greatly influence the future deployment direction.

For reference purpose, the longer term implementation could focus on the moderate priority project concepts presented in Table 3.2 in Chapter 3. They are repeated below:

7.3.1 Moderate Priority Projects (5 to 10 year implementation)

1. **Adaptive Signal Control -** Adaptive signal control can reduce the staffing and operation time to update signal timings. Traffic variation and travel demand changes will necessitate continuously development of new signal timing plans. An adaptive signal control system can develop timing plans based on actual traffic conditions in the field. In the US, both SCOOT and SCATS have been

implemented, though with mixed results because they are both developed outside of the US FHWA has commissioned a project called RT-T'RACS to develop an adaptive signal control system that works with the US dual-ring configuration. It is expected to take 3 to 5 years before the software is available.

2. **Transit Priority in LVACTS** - Through the working group discussions, the need for transit priority within LVACTS had been discussed. Providing some form of partial priority to buses can greatly help those that are behind schedule. This can be done by extending the green time for the buses at selected intersection at selected times of the day. The degree of green extension affordable at each intersection at different times needs to be established through detailed operational analyses, and consensus among RTC and LVACTS is paramount. The manner in which the buses requests priority can also range from manual (operator at RTC requests operator at LVACTS to activate green extension along certain route) or automatic (equipment on buses will communicate with the local signal controller to request priority; the controller's response may be determined by built in software). Many transit priority systems are being developed and will become mature in the next two to five years.

3. **Traveler Information on Internet** - The Internet is receiving increased popularity as a means of obtaining information. Many states have developed web sites that provide traveler information, including Washington, California, Minnesota, and others. Some of these web sites provide graphical data of real-time traffic conditions updated every 15 seconds or so. Some even allow the user to interactively request travel time estimates by clicking the mouse on an origin and a destination. With the completion of the traveler information database, dynamic traveler information would be provided through cable TV in the first 5 years. This information can also be provided on Internet at a relatively low cost.

7.4 Private Sector Roles

Within this ITS strategic plan, many projects are considered suitable for private sector participation. Some may even be considered as private sector lead projects:

1. **Smart Shuttles**

   Smart Shuttles are door-to-door shuttle service for commuters allowing real-time ride-matching. Large employers such as the resort corridor employers can pool together to provide this service for their employees. The benefit of this program to the employers include punctual arrival of employees and reduction of employee parking needs.

The shuttles would be a fleet of vans equipped with GPS and in-vehicle communication equipment. Commuters would call a telephone number to request the service, providing origin, destination and desired arrival time. The operator receiving the call would use the dispatch computer to determine the best vehicle for pick-up. Confirmation of pick-up time can be sent through phone, fax or pager back to the commuter.

With the resort corridor having employees running shifts, this service can be provided around the clock. Besides picking up employees, it can also be used to pick up patrons of the hotels and casinos. A preliminary discussion with the Resort Association indicates that there is an interest for the private sector to provide this service especially when employee parking spaces can be reduced. Many hotels along the resort corridor already own a fleet of vans for picking up patrons.

2. Airport Traveler Information System

An airport traveler information system would provide ground access traveler information at or near the airport. This can be done through multiple channels such as changeable message signs, highway advisory radio, lane signals, etc. Information can be provided include curbside pick-up/drop-off locations, route guidance, parking availability, and flight arrival information. The Airport Department of Aviation should be the lead in this deployment, and common data and video links can be connected to the regional TMC.

3. Kiosks

Kiosks can be used to provide traveler information to tourists and commuters. They can be located at rest stops, hotels, airports, downtown transportation center, park-and-ride lots, and so on. Besides providing traveler information, it can also provide other "yellow page" traveler service information such as business locations. An interactive screen can allow users to make hotel, restaurant and show reservations, as well as provide route guidance to the destination. The private sector can fund the kiosks while the public sector can provide the necessary traveler information.

4. Personal Data Assistants (PDA)

Personal data assistants are hand held devices for travelers to obtain traveler information. Due to the large amount of visitors to Las Vegas, a portable hand held device that can provide travel information and direction guidance can be useful Since many of them are family vacationers, the use of rental cars is increasing significantly. There exists a potential for PDAs to be rented at car rentals and hotels whereby visitors can obtain directions. Similar to the kiosks, these PDAs can also be made interactive whereby the users can make hotel, restaurant and show reservations.

5. Rental Car Navigational Equipment

Avis and Hertz have started to provide in-vehicle navigation devices in Los Angeles and other cities. Las Vegas, having a large number of visitors daily, stands to gain from having this system installed in rental cars to help provide route guidance to visitors.

6. Resort Corridor (and other major attractors) Signing System

With over 29 million visitors, the resort corridors often experience severe congestion. This might negatively impact delivery, employee or patron access to the resorts. Currently, the only parallel routes to the Strip are Koval Lane and Paradise Road to the east and I-15 to the west. With the proposal to build a new road west of the Strip providing backdoor access, a system of changeable message signs can be mounted to provide dynamic directional guidance to the resort properties.

Similar to the Resort Corridor, other local attractions such as the Speedway may offer opportunities for private sector to provide traveler information and variable signing systems.

7. Private Transit/Taxi probes

A large number of private transit (shuttles and limousines) and taxicabs are traveling the congested corridors. About 170 taxicabs are already equipped with GPS equipment. Most vehicles currently communicate through CB radio or cellular phone with their dispatch center. They commonly broadcast traffic information for the benefits of their drivers. A linkage with these private operators will allow using these vehicles as probes to report traffic conditions to the TMC, and also for the TMC to disseminate other relevant information to them. This linkage can be by voice (through radio or phone) or by electronic means (in-vehicle computer). This project will require full support and interest from the Nevada Taxicab Authority and taxi operators.

8. Smart Cards

Smart cards are multiple purpose fare payment cards that would enhance ease of transit payment. These cards can be used interchangeably for multiple purposes such as transit fare payment, events attendance or other private purposes. These cards can also be provided as “convention transit passes” to promote transit usage. Based on the unique characteristics and needs for the Las Vegas Valley, before private sector needs to take the lead to develop these smart cards.

APPENDIX

A. PROJECT CONCEPTS

The ITS Strategic Plan development starts from identifying the needs of the region. Based on the User Service Plan, a number of user services were considered high priority for the Las Vegas Valley. These are classified into four program areas:

- Traffic Control
- Traveler Information
- Public Transportation
- Incident Management

For each of these program areas, a number of project concepts were developed as potential tools for addressing the needs of the Las Vegas Valley. Through a workshop involving the Steering Committee and the joint working groups, these project concepts were prioritized into high priority, medium priority and low priority. The high priority programs were then defined in further detail for implementation within 5 years. This chapter discusses the project concepts and the results of the workshop. Chapter 4 provides the detailed elaboration of the high priority programs.

It should be noted that the project concepts listed in here merely represent considerations during the workshops. Some of these projects were subsequently dropped from further consideration after the workshop discussions.

APPENDIX

A.1 Traffic Control Programs

A.1.1 Adaptive Traffic Signal System

Purpose: To provide adaptive traffic signal control to allow dynamic response of traffic signal timing due to varying traffic conditions.

Description: Traffic flows on major arterials (especially along the resort corridor) varies significantly. The peak periods may be in late night on weekends. Currently fixed time control is the adequate for normal operations but cannot handle large fluctuations of traffic flows, as experienced during special events. Providing an adaptive traffic control system will allow real-time changes of signal timing in response to traffic demand.

Key Issues:

- Current LVACTS upgrade does not include adaptive traffic control capabilities. Parallel processor kernel can be developed to operate adaptive control side-by-side with LVACTS.
- Current adaptive control system vendors are limited to SCOOT (Peek, Siemens) and SCATS (AWA). FHWA is researching a new adaptive control algorithm called RT-TRACS. It may be available in 3-5 years.

Possible Private Sector Partnership Opportunities: None, unless the private vendors would be willing to donate equipment to perform a pilot test at, say, along “the Strip.”

A.1.2 **Photo Radar for Speed and/or Red Light Violation**

Purpose: Improve traffic safety by enhancing enforcement of speed and red-light violation. Free up police to investigate accidents.

Description: At designated high accident/incident locations, install cameras to capture on film either speed or red-light violators. Violators will be cited by mail. Owners of vehicles can inspect photograph at court to identify driver. Equipped locations would be signed to warn drivers. "Scarecrow" signs can also be deployed at some locations.

Key Issues:

- Need to change legislation to allow citations by mail
- Privacy concerns
- How to cite rental car drivers
- How to cite out-of-state vehicles

Possible Private Sector Partnership Opportunities: Complete privatization. Some companies would install, operate and maintain system, including mail citation, in return for a percentage of the citation revenue.

A.1.3 **Selective Transit Priority in LVACTS**

Purpose:

Buses are more effective in moving people than single-occupant vehicles. Therefore, they should be given priorities in the traffic signal system. At a minimum, selected routes in the off-peak period might offer transit priority. Also, selected vehicles that are behind schedule need to receive priority more than others.

Description:

Various means of transit priority can be provided, ranging from full preemption such as the "Opticom," to partial selective priority by extending the green time by the signal control operator. Full preemption would be too disruptive to the signal timing and may negatively impact other traffic flows. Selective partial priority is more "palatable." Typically, this would require local software in the traffic signal controller to determine if a given green phase can be extended to accommodate an approaching bus. Ultimately, the signal system could be tied to the transit AVL system whereby the AVL would send priority request for selected buses that are behind schedule. The central signal system software would then determine if such a request can be accommodated.

Key Issues:

- Under the current LVACTS configuration, this traffic responsive capability may not be implementable. Central and local software changes may be necessary.
- The link between the transit AVL and LVACTS needs to be developed.

Possible Private Sector Partnership Opportunities:

A.1.4 **Freeway Management System**

Purpose: To facilitate efficient traffic operations on freeways

Description: Provide some or all of the following features on freeways:

- Ramp metering
- Changeable message signs (CMS)
- Closed circuit TV cameras (CCTV)
- Expanded detection system
- Communication network
- Highway advisory radio (HAR)

Key Issues:

- Funding availability
- Location of freeway management center
- Inter-tie to LVACTS

Possible Private Sector Partnership Opportunities:

- Telephone companies provide communication network in exchange for use of state right-of-way.
- Joint provision of CCTV coverage with media.

A.1.5 Railroad Arrival CMS

Purpose:

Railroad safety is a concern. Anxious drivers often speed up to cross the tracks when the gates begin to lower. Some drivers might drive around the lowered gates. One way to minimize accidents is to discourage such drivers from "running down" the train by providing information to them when they are sufficiently upstream of the railroad crossing such that they can make detour choices.

Description:

In order to provide drivers an opportunity to detour around a railroad crossing while a train approaches, changeable message signs (CMS) would be mounted at upstream intersections approximately l/4 mile from a railroad crossing. Traffic signals and gates near the railroad tracks should be timed to allow clearance of all vehicles within a 114 mile from the railroad crossing before the gates are lowered. Whenever a train approaches, the CMS would display a warning message with the train direction and approximately train passage time. Drivers can then decide whether they would want to detour.

Key Issues:

- To be effective, additional detectors need to be installed in the railroad tracks to provide more advance detection of trains and record passage time. The railroad companies need to be involved.

Possible Private Sector Partnership Opportunities:

Involve the railroad companies in the design.

A.1.6 **Regional Traffic Detection System**

Purpose: Provide reliable traffic information through detection

Description: Provide detection devices throughout the transportation network, including freeways and major arterials. Many detection means are available:

- Detector loop (some existing within LVACTS and on freeways)
- Video detection
- Bus probes
- Rental car probes
- Taxi probes
- Infrared, ultrasonic or other means

Key Issues:

- More information sources equates to be better reliability of information
- Need to tie with LVACTS upgrade, where more loops detectors will be installed.

Possible Private Sector Partnership Opportunities:

- Rental car companies can provide AVL probe information
- Taxicabs can provide probe information.

A.1.7	**Regional Traffic Management Center**
Purpose:	Facilitate regional coordination of traffic control, traveler information and incident management.
Description:	Provide an integrated center for LVACTS, freeway management system, traveler information system and incident management.
Key Issues:	• What functions to be integrated? or not integrated? • Staffing requirements • Funding formula for operations
Possible Private Sector Partnership Opportunities:	• Privatized traveler information function within center.

A.2 Traveler Information

A.2.1 Kiosks

Purpose: Provide traveler information to tourists and commuters.

Description: Install kiosks at rest stops, hotels, airports, transportation centers, park-and-ride lots, etc., to provide traffic conditions, CAT routes, CAT schedules, *CAT* costs, route guidance for drivers and other "yellow page" traveler service information.

Key Issues:

- What information to provide and where will they come from?
- Should kiosks be interactive with touch screen functions to allow, for example, hotel reservations?

Possible Private Sector Partnership Opportunities:

- Led by private sector with traffic information from public sector.

A.2.2 Regional Traveler Information Center

Purpose: Provide single center for centrally processing and disseminating all traveler information.

Description: Provide and staff a regional traveler information center responsible for gathering traffic information from detectors, transit probes, taxicabs, construction activities and other sources. The center would process real time information and disseminate the same through multiple means to the public.

Key **Issues:**

- Should there be one center or multiple centers?
- Should the center be integrated with LVACTS and the freeway management center?
- Staffing needs

Possible Private Sector Partnership Opportunities:

- Various functions can be privatized.
- Private sector can package information and sell it to the public.

A.2.3 Cable TV Traveler Information Channel

Purpose: Provide easy access to traveler information in many homes and hotel rooms.

Description: Provide one or several channels on cable TV for real-time traffic conditions, work zone detour information, incidents information and airport airlines information.

Key Issues:

- Where would information come from?
- Information needs to be real time and updated reliably

Possible Private Sector Partnership Opportunities:

- Cable TV company needs to participate.
- Department of Aviation can provide airlines information to cable TV directly.

APPENDIX

A.2.4 **Personal Data Assistants (PDA)**

Purpose: Provide traveler information to tourists, rental car drivers, tour bus drivers, out-of-town drivers

Description: Provide hand-held units (approximately the size of a calculator) that can receive traffic information through radio reception. One-way radio would mean that traffic information would be transmitted to all units at the same time. Two-way radio would allow the user to interactively select specific information. The same can be applied to pagers.

Key Issues:

- Need private sector development of PDA units.

Possible Private Sector Partnership Opportunities:

- Completely private sector lead to develop PDA units, taking information available from the public sector.

A.2.5 **Traveler Information on the Internet**

Purpose: Provide traveler information through the Internet

Description: Provide a page on the Internet where users can obtain real time traveler information, traffic conditions, congestion maps or incident information. This is taking place in San Diego, Los Angeles, Seattle, Chicago and many other cities.

Key Issues:

- Is the Internet penetrating the market enough locally in Las Vegas?

Possible Private Sector Partnership Opportunities:

- Private sector can take the public information and put it on the Internet. For example, Maxwell Laboratories has put San Diego traffic detector information on the Internet for the past several years.

A.2.6 l-800-COMMUTE

Purpose: Provide traffic condition information via the phone

Description: Provide a toll free phone number whereby the public can call in for pre-recorded traffic information

Key Issues:

- Is the information reliable and updated frequently enough?
- Who should be lead agency operating this?

Possible Private Sector Partnership Opportunities:

- Private operator of phone services, combining with tourist information possibly

A.2.7 **Airport Traveler Information System**

Purpose: Provide ground access traveler information near the airport

Description: Airport access traffic would be provided information through multiple channels such as changeable message signs, highway advisory radio, lane signals, etc. Information to be provided includes curbside pick up/drop off locations, route guidance, parking availability, etc. To be effective, some CCTV surveillance of access roads will be required.

Key Issues:

- Should this system be operated by the Department of Aviation? Or should it be operated by the freeway management system and the LVACTS operation center?

Possible Private Sector Partnership Opportunities:

- Partnership with Department of Aviation.

A.2.8 **Rental Cars Navigational System**

Purpose: Provide better trip direction information for rental car drivers, which account for about 30,000 vehicles per day.

Description: Provide in-vehicle navigational devices in rental cars. Avis and Hertz have started to provide these equipment in some cities. The current devices merely provide map information on a monitor. More advanced forms of in-vehicle navigational devices would also recommend routes based on parameters that the user selects (e.g. Travtek demonstration in Orlando). This would require connection to traveler information system to obtain real-time traffic conditions and use of path-optimization software.

Key Issues:

- What is the role of public sector?

Possible Private Sector Partnership Opportunities:

- Rental car companies need to take the lead.

A.2.9 Linkage to Private Transit and Taxicab GPS

Purpose: To obtain and provide information to and from private transit and taxicabs

Description: A large number of private transit (shuttles and limousines) and taxicabs are traveling in the congested corridors. These vehicles may be equipped with GPS (170 cabs will be equipped). Most vehicles communicated through CB radio or cellular phone with a center. Traffic conditions are broadcast for the benefit of all drivers. A linkage between these private operators and the traveler information center will allow two-way flow of information. The traveler information center can obtain first hand traffic conditions report from these private operators and also disseminate other relevant information to them. The linkage can be by voice (through radio or phone) or by electronic means (autofax, pager, PDA, in-vehicle navigator, etc.)

Key Issues:

- A regional traveler information center must be set up first.
- Would private transit and taxicab operators be interested?

Possible Private Sector Partnership Opportunities:

- Require interest and full support of the private sector.

APPENDIX

A.2.10 **Resort Corridor (and other major attractors) Signing System**

Purpose:

With 28 million visitors, the resort corridor often experiences congestion caused by either excessive demand or incidents. This negatively impacts delivery, employee, or other access to the resorts. Currently, the only parallel route to the strip is Koval Lane, Industrial Road and Paradise to the east. With the proposal to build a new road west of the strip to allow backdoor access, a system of changeable message signs can be mounted to provide dynamic directional guidance to the resort properties.

Similar concepts can apply for other major attractors such as the Speedway, providing signing for travelers.

Description:

Provide a system of changeable message directional signs for traffic accessing the resort corridor. These signs can provide direction to resort properties and vary according to traffic condition of the strip and the parallel facilities.

Key Issues:

- With a large number of resort facilities, the signs cannot provide direction to every property. The Resort Association needs to be involved in the design of the signage scheme.

Possible Private Sector Partnership Opportunities:

- The system can be funded by the resort properties, similar to the landscape project along the strip currently underway.